THE
# physiotherapy
REVIEW

**Twenty-Fifth Anniversary**


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# The Physiotherapy Review

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**Volume 26** **NOVEMBER-DECEMBER 1946** **Number 6**


## Physical Therapy in Orthopedics:

### *With Special Reference To Heavy Resistance, Low Repetition Exercise Program*


**Dorothy G. Hoag, 1st Lt., M.D.P.T., A.U.S.**


In treating orthopedic conditions, the surgeon is mainly concerned with the prevention and correction of deformity, wheras the aim of the physical therapist is to maintain and restore function under the direction of the surgeon and the chief of physical medicine.

The orthopedic patient usually receives his first physical therapy treatment while he is still a bed patient. For example: heat, massage, active or active-assistive exercises with mild stretching in certain cases usually will be prescribed for the patient who has a fractured femur, who is bedfast in traction, leg splint, or bivalved cast, or nonambulatory due to pain or edema. In a large number of cases the first thirty or forty per cent of the range of motion is regained rapidly by employing this treatment during the first few weeks. During the following weeks, the gain usually is slow. Even as resistance is applied, the gain is not appreciable in a large number of cases.

When the patient becomes ambulatory or is brought to the physical therapy clinic in a wheelchair or on a litter, he receives hot packs, radiant heat, diathermy, whirlpool, or Hubbard tank treatments in an attempt to reduce the pain and edema or to relax the ligaments and joint capsules in order to gain more range of motion.

Obviously, all physical therapy in orthopedics is not directed toward increasing range of motion, but it is an important part of it. Other types of patients who come to the physical therapy clinic are those with muscle weakness who may or may not have limited range of motion. In the past, manual resistive exercises, exercises with pulley weights, and a number of other endurance exercises, such as stair climbing or stationary bicycle riding exercises have constituted the strengthening exercise program. Good results have been obtained, usually over a long period of time, but often the patient left the hospital with considerably less muscle bulk in the affected extremity than in the normal one.

A few specific types of cases which fit into these two categories will be discussed briefly:

1. Healed comminuted fractures.
2. Cases of immobilization of one or more joints.
3. Meniscectomies and unstable knees resulting from ligamentous tears.
4. Cases with loss of muscle tissue due to lacerating wounds.
5. Postoperative chest conditions.

In some comminuted fractures, deep scarring with subsequent fibrotic changes and severe adhesions in the muscles may be responsible for the slow gain in range of motion after a certain point is reached. With the usual physical therapy measures, gain in strength as well as range of motion is very slow.

After long periods of immobilization of one or more joints, even though not directly concerned in the injury, the muscles rendered inactive by immobilization frequently become hard and fibrosed due to the inactivity[1]. Attaining range of motion and strength in these cases often is a difficult problem.


Physical Therapy Section, Fitzsimons General Hospital, Denver, Colo.



Read before the Twenty-Third Annual Conference of the American Physiotherapy Association, Blue Ridge, N. C., June 21, 1946.

In cases of meniscectomies and unstable knees with associated ligamentous tears, ordinary treatment frequently does not obtain satisfactory results. Even though the patient performed the standard quadriceps progression exercises for three or four weeks, he may have synovitis of the knee, which is aggravated by weight-bearing exercise. With insufficient quadriceps power, the problem of stability rests entirely on the ligaments. The twisting in the relaxed joint caused by weight-bearing exercise injures the synovial membrane, and pain and swelling result. To prevent this, the development of quadriceps power before weight bearing is recommended in meniscectomies. In unstable knees, the quadriceps power is essential to take over the stabilization lost because of the torn ligaments.

Patients with soft tissue wounds with an actual loss of some muscle tissue present the problem of restricted range of motion. If scarring and adhesions develop, weakness due to the loss of muscle substance presents an additional problem.

After the patient has received surgical or medical care and the preliminary physical therapy treatment, the development of muscle power is the most important factor in restoring normal function. As this power is developed, fibrosed muscles begin to soften and regain normal consistency, even though the atrophy and hardness may persist. Deep scars are gradually loosened and in these cases, range of motion can be increased. The method for developing power is that of the heavy resistance, low repetition exercise program developed by Captain Thomas DeLorme, M.C., AUS, formerly of Gardiner General Hospital, Chicago, Illinois[2].The old accepted theory was based on low resistance exercises performed a great number of times. This developed endurance but not power. It is logical that weakened, atrophied muscle should not be subjected to endurance building exercises until normal muscle power has been restored. It appears advisable to develop muscle power in the affected extremity, equal to that of the normal extremity. When the strength of the two is approximately equal, the endurance exercises are begun.

The quadriceps will be used as a typical example in the following description of the exercises and the various procedures. In order to make it easier for the physical therapist to observe full extension of the knee, the patient wears shorts. The following data is recorded for both legs the first day: The degree of flexion and extension of the knee, and the circumference of the leg at three levels—eight inches above the base of the patella, three inches above the patella and the largest part of the calf. Also, signs of pain, edema or crepitation are noted on the data sheet. If edema is present, an additional measurement is taken around the knee joint.

The patient is then seated with legs flexed at a ninety degree angle on a table thirty-six inches high and about fifty inches wide. The table should be well built since it will be subjected to considerable strain. The front edge should be raised about three inches and well padded for comfort, so that when the lower leg is extended, the entire lower extremity will be parallel with the floor. It is well to have a pole along the middle of the table, so that the patient can lean back and grasp it for stabilization as he partially extends his hips for better advantage of the rectus femoris.

Extension always should be complete, or as nearly complete as possible. The leg should be extended and lowered at the same rate, slowly and rhythmically. A pause at the end of each repetition is advisable. The importance of complete extension is especially stressed in this case, since it has been demonstrated that the vastus internus functions chiefly in the last fifteen degrees of the arc. The rapid atrophy of this muscle is coincident with the inability to accomplish complete extension of the leg. If there is inability to extend the knee through the last fifteen degrees of the arc, it is advisable to add weights since this muscle functions through a much larger range against heavy resistance. In this way, power is built in the vastus internus which will eventually make it possible to achieve complete extension. Only the affected extremity is exercised until both are approximately equal in strength. Then it is advisable to exercise both extremities since the unaffected one may have been considerably weakened from disuse.

Before resistance is applied, the leg should be "warmed up" by exercising through the range of motion ten or fifteen times. Then, an iron boot which weighs five pounds and was made especially for leg exercises is strapped onto the shoe. It is fitted with a short iron pipe for attaching iron plates graded from one and one-fourth to twenty-five pounds to add the correct amount of resistance.

There were patients who were unable to lift five pounds, which is the weight of the boot. In these cases, a leather cuff was laced around the ankle with a strap on the back to hold a canvas bag in which were placed sand bags, graded from one-half pound to five pounds.

The weight used for the daily exercise is determined by the following test performed the first day. Starting with the weight of the boot,

or bag and cuff, the maximum poundage which can be raised ten times is determined by adding small increases of one to five pounds. The increased weight lifted ten times determines the maximum and is called the ten RM or ten repetition maximum.

The one RM, or repetition maximum is determined on the same day. After the ten RM is reached additional poundage is added. As weight is increased, fewer repetitions can be performed until finally the weight which can be lifted only once is reached. This is recorded as the one RM, or the actual index of power. On this same test day, the maximum power and thigh measurements of the unaffected extremity also are determined. When both thigh measurements are equal, maximum results may be said to have been obtained unless it is believed that the unaffected extremity is weakened from disuse. Then exercise of both extremities should continue.

After the initial test day the patient is ready to start the daily program, which includes five days of exercise a week. The maximum number of repetitions performed in a series, regardless of the weight, is fifteen but the usual number is ten or twelve. The total number of repetitions for one exercise period varies from seventy to one hundred, lasting for approximately one-half hour. Since seventy to one hundred repetitions must be performed and each weight must be lifted ten or twelve times, the workout begins with considerably less weight than the ten RM. For example, the ten RM is twenty pounds. By starting with five pounds and increasing two and one-half pounds after each series, seventy repetitions will have been performed when twenty pounds is reached. To obtain more than a total of seventy repetitions, each series may consist of twelve repetitions or the initial weight and early increases may be lessened by using sandbags. The weight increases will vary, of course, dependent on the ten RM. If it is much higher, the weight increases may be from five to ten pounds. If the ten RM is five pounds or less, it will be necessary to use the same weight for two consecutive series in order to reach the total of seventy to one hundred repetitions.

At the end of each week, the same data obtained in the initial test is redetermined. This will not only show the rate of improvement, but the new ten RM will be the index for the exercise to be performed the following week. Since the week of exercise consists of five days, it is advisable but not always practical, to designate Friday as the test day. Then, the patient has his two-day rest over the weekend after his maximum exertion.

This procedure may be applied to any joint movement or muscle group to which resistance may be given. Alterations are made only in the equipment used and the measurements taken. In shoulder flexion and abduction, it has been found more successful to use both arms, lifting weights at the same time. This is primarily to avoid poor postural positions of the shoulder while appearing to attain more range of motion. It is quite common for the patient to "hunch" the shoulder or lean to the opposite side so as to appear to have more range. In other cases where range of motion may be very limited, such as flexion of the knee, plantar flexion or dorsiflexion of the ankle, it may prove advisable to exercise both legs for a time in order that the normal leg may assist the affected one. In cases of bilateral injury or weakness, both extremities should be exercised. If the weakness in the lower extremities is fairly uniform, both may be exercised simultaneously with two boots fitted on the same bar.

With various arrangements of pulleys and other equipment, a great number of exercises can be worked out. The technics, procedures of weight increase, frequency and length of workout are the same regardless of the joint involved.

A comparison of data obtained after a few weeks of the heavy resistive low repetition exercise program with that obtained at the initiation of the program reveals rapid progress.

A patient with a compound comminuted fracture of the left humerus with loss of substance in the biceps and brachioradialis as well as deep scarring in the upper arm gained twelve degrees of elbow extension in two weeks. His gain during a three month period previous to taking heavy resistance exercise was very slow. His increase in the one RM was two pounds.

A patient with a bone graft in the upper third of his right radius lacked sixty-four degrees in elbow extension. After four weeks of heavy resistance exercise, his one RM increased five pounds and he gained thirty-four degrees in extension.

A patient with a lacerated medial ligament of the left knee with a possible rupture of the medial meniscus gained thirty degrees in knee flexion and experienced marked decrease in pain and edema during a six weeks period of exercise.

Another patient with a dislocation and ligamentous tears in the knee was unable to bear weight because of pain. After six weeks of heavy resistance exercises, he gained one and one-half inches in the upper thigh measurement as his one RM increased twenty pounds. Treatment was dis-

continued when he was free from pain and able to walk normally.

It is not intended that heavy resistance be advocated as a panacea, but in most cases the results have been very satisfactory. There are a few patients who have not responded to the treatment. In some cases this has been due to lack of interest and effort on the part of the patient, or to joint conditions which could not be improved by increased muscle power.

### *Conclusions*

1. Heavy resistance, low repetition exercise develops power after which the patient is ready for endurance building exercises.
2. Exercise against heavy resistance results in hypertrophy of atrophied muscle.
3. Restoration of power is accompanied by increased range of motion with the breaking down of scar tissue and return to more nearly normal consistency of the fibrosed muscles.

#### REFERENCES

1. Magnusson, P. B.: Fractures. Fourth edition revised, pp. 452-547. Philadelphia: J. B. Lippincott Company, 1942.
2. DeLorme, Thomas: Restoration of Muscle Power by Heavy-Resistance Exercises. J. Bone and J. Surg., Vol. VII, No. 4, pp. 645-667, October 1945.

#### DISCUSSION

*Donald L. Rose, M.D.:* The program presented in this excellent paper represents a much-needed addition to the armamentarium of therapeutic exercises. The factors underlying the employment of heavy resistance exercises are well known to physiologists. This method successfully translates into clinical use the principle of producing muscle hypertrophy by progressive loading of that muscle. Since muscle development is necessary for the proper function of the part concerned, this procedure should enjoy widespread application in clinical use.

In the opinion of the discussant, the heavy resistance-low repetition exercises are superior to other forms of exercise for the development of muscle power in certain muscle groups. The chief advantage of these exercises lies in their dosage. The defect inherent in pulley weights and helical springs is that one cannot determine and control the weight which loads the muscle. With the heavy resistance exercises, the load may vary from that of active motion only to many pounds, and the gradations between these extremes are known and can be controlled by the physical therapist. Thus, it is quite possible to increase or decrease the work load in as controlled a fashion as is the dosage of drugs and similar agents. Aside from the favorable clinical response, it is this element of controlled dosage which is of particular interest.

It should also be mentioned that not all of the beneficial results of this method are related directly to the muscle hypertrophy produced. Actually, in many cases hypertrophy alone has an importance quite secondary to other factors, such as the improvement of circulation to that part. It is believed that the diminution in capsular and intramuscular fibrosis may be largely due to the improvement in circulation. In partial substantiation of this belief is the demonstration, which has been noted repeatedly, of an increase in skin temperature in the region being exercised. Rises in skin temperature of 8 to 10 degrees F. are not unusual, and return to normal skin temperature does not occur for several hours. This would imply increased blood supply to that part during this period.

It is urged that this method of therapeutic exercise will not be employed to the exclusion of other, time-proven methods. Valuable though this method is, it represents but another phase or facet of the field of therapeutic exercise. In its present stage of development, this method is most successfully adapted to exercise of the quadriceps group. It appears to be less adaptable to other muscles. In other words, the discussant simply wishes to warn that there are indications, contraindications, dangers and limitations to this method. All factors must be weighed before this or any other method be prescribed and employed.

The question has been raised from the floor relative to the employment of heavy resistance exercises in the after-care of poliomyelitis. Such exercises are being employed in selected cases under carefully controlled conditions. Until the many unknown factors concerned in such use are delineated more accurately than is true at the present time, it is not recommended that this method of exercise be employed in this condition.

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## Exhibits Available

1. Two sets of slides with script: "Physical Therapy Procedures," and "Course Content in Physical Therapy."
2. Two posters, each containing eight black and white photographs, entitled "Physical Therapy Procedures."
3. Poster showing photographs of equipment used in physical therapy departments. Miniature models of the equipment accompany the poster.
4. Album of photographs of therapeutic exercises.
5. Two posters showing photographs of exercises for faulty posture.

Maxine Schuldt, 2031 Dwight Way, Berkeley, California, has taken over the chairmanship of the Exhibits Committee. All requests and other correspondence regarding exhibits should be addressed to her.

# Physical Therapy in Treating Peripheral Vascular Diseases:

## *With Particular Emphasis on Trench Foot*

**Georgiana Windham, 1st Lt., M.D.P.T., A.U.S.**

Peripheral vascular diseases treated at Brooke Army Medical Center during the period of 1941-1946 consisted largely of trench foot cases. Therefore, this paper will be limited to a discussion of generalizations drawn from the treatments administered to 2500 patients with the clinical diagnosis of trench foot. The trench foot section under the Surgical Service of Brooke General Hospital was directed by Major Kenneth Hansen, M.C., of Cincinnati, Ohio.

A review of medical history reveals that trench foot is not a new medical problem. The first mention in literature of mass cold injury during military campaigns was made by Larrey, Napoleon's surgeon. It was again mentioned by the British surgeons at Tripoli. A great number of cases were reported during the first World War. The recent World War also had many cases, occurring in the Aleutian campaign and the Mediterranean and European Theaters of Operation. In Europe many thousands were evacuated from the line because of cold injury, so-called trench foot. Ninety-five per cent of the cases in the European Theater of Operations occurred in four areas: Huerton Forest near Aachen, the Battle of the Bulge, the Colmar Pocket and the Battle of Metz. The report of total monthly admissions on the continent in November 1944 showed that of 41,793 battle casualties admitted to the hospitals, 6,869 were trench foot cases. In December 1944 there were 37,336 battle casualties and 11,469 trench foot cases.

Various clinical diagnoses have been applied in the past to the varying effects of overexposure to cold. Major Hansen believes the difference is one of extent and degree of cold; frostbite is the actual freezing of tissue; immersion foot refers to the method of acquiring the injury; frozen foot means exactly what it indicates; trench foot is the same type of injury apparently occurring after prolonged exposure to wet cold at just above freezing temperatures (34-40 F.). However, in this war, the injury might have been called "foxhole foot." Trench foot is not to be confused with contagious diseases such as athlete's foot and trench mouth.

Regardless of the name given this condition, the pathological changes which occur are essentially the same. The first reaction to cold is a blanching of the skin which is attributed to a constriction of the blood vessels. If cold is prolonged, the foot becomes cyanotic due to lack of oxygen and reduced blood flow. The next stage is a red cold, where the skin appears flaming red. There is no sensation of cold in spite of the reduced temperature. The red blood cells retain the oxygen with beginning fluid loss due to capillary permeability. If this stage is prolonged over twenty-four hours, the first clinical symptoms of freezing will appear and can be classified as trench foot, mild. As circulation is restored to the foot, an intense reactive hyperemia appears, giving rise to blisters, intracutaneous ecchymosis and edema. In this hyperemic stage, three predisposing factors for the development of trench foot are always present: (1) physical cold; (2) prolonged exposure at rest, producing ischemia, followed by (3) physical activity of the damaged part.

If the exposure to cold is of a sufficient degree, gangrene takes place, resulting in death of tissue en masse. With lesser degrees of exposure, gangrene may not take place, and the tissue may not be completely devitalized. This partial damage usually manifests itself by a loss in nervous irritability, either sensory or motor or both, and muscle paralysis or paresis.

With therapy, there is a gradual return to normal, the degree of complete recovery depending upon the severity of the case. About twenty-five per cent of the cases pass through the phase of secondary vasospasm, in which there are periods of blanching, hyperemia, edema and pain.

The late pathological change is primarily one

Brooke General Hospital, Fort Sam Houston, Tex.

Read before the Twenty-Third Annual Conference of the American Physiotherapy Association, Blue Ridge, N. C., June 21, 1946.

EDITOR'S NOTE: This paper was supplemented by some excellent colored slides which portrayed in detail the routine physical therapy procedures employed in the treatment of this type of patient.

of the deposition of fibrous tissue throughout the structure of the foot. This takes place in or about the smaller blood vessels, nerves, muscle tissues, and tendons. In the cases observed, the osseous changes showed a fair percentage of decalcification, which was believed to be due to disuse rather than a fundamental change resulting from the cold injury. There was also secondary atrophy in the larger muscle groups of the leg caused by disuse.

Concurrent with these changes there is excessive perspiration in the foot and loss of muscle strength, with pain and sensitiveness centered in the metatarsal area. The deformity most often confronted is a shortening of the extensor tendons of the four lesser toes, a dropped great toe, and a stretching of the peroneal muscles, with a shortening of the tibialis anterior and tibialis posterior muscles. This deformity is caused by the weight being borne on the heel and outer border of the foot in order to protect the great toe, the metatarsal area, and the medial longitudinal arch, where most of the pain occurs. A typical trench foot gait is one in which the patient walks with foot inverted, weight centered on the heel, with no metatarsal action, and with the feet placed wide apart to aid in maintaining balance.

Physical therapy is contraindicated in the early stages. The usual treatment consists of bed rest with the foot elevated and kept cool. In the subacute and convalescent stages, the physical therapist's aim is to alleviate the pain and to teach the patient to walk with a normal gait. Objectives of treatment are as follows:

1. To increase circulation.
2. To increase flexibility and range of motion in ankles, metatarsophalangeal and interphalangeal joints.
3. To increase muscle strength and tone in the extremities.
4. To decrease edema and tenderness of feet.
5. To encourage the patient in his personal attempts to improve his physical condition.

The physical therapy procedures used in attaining these objectives are:

1. Massage with passive stretching of contracted muscles.
2. Active exercise.
   a. Special non-weight-bearing foot exercises.
   b. Muscle reeducation.
   c. Weight-bearing exercise including corrective walking.
3. Hydrotherapy.
   a. Whirlpool (warm).
   b. Contrast baths.
4. Iontophoresis with mecholyl.
5. Diathermy.
   a. Lumbar region.
   b. Directly to the feet.
6. Passive vascular exercise.
7. Ultraviolet radiation.

The above methods of treatment have been used alone or in various combinations, depending upon the condition of the patient. In evaluating their results, it must be kept in mind that all conclusions and statements are generalizations drawn from the results visible to observers and from the statements of the patients concerning their own reactions.

It is believed that massage and exercise give the best results in most cases. Foot massage is given with emphasis placed on passive stretching of the tendons of the extensors brevis and longus digitorum muscles. Deep petrissage and friction over the metatarsal area combined with passive exercise of the metatarsophalangeal and interphalangeal joints induces increased flexibility and range of motion of these joints. Massage also appears to aid in increasing the collateral circulation, alleviating pain and relaxing taut muscles.

Corrective non-weight-bearing exercises are important in developing strength and coordination in the intrinsic muscles of the foot as well as aiding in the stretching of tendons, thus decreasing existing deformity. Emphasis is placed on eversion exercises to strengthen the peroneal muscles, and at the same time to teach the patient to relax the tibialis anterior and tibialis posterior muscles. Special toe exercises consist of picking up objects, gripping a towel, flexing toes over a wand, and any other exercise which provides flexion and extension of toes and metatarsophalangeal joints. Tapping the heads of the metatarsal joints against the floor and using the ankle exercise apparatus for flexion and extension, emphasizing pressure on the metatarsal area, are good exercises which prepare the patient for correct weight bearing. Graduated exercises are continued daily in the physical therapy section and several times a day without supervision on the ward, until the patient is ready for weight-bearing exercises and corrective walking.

Buerger's exercises have been used in some cases both on the ward and in the physical therapy clinic. This type of exercise appears to stimulate circulation for a few hours following treatment. Muscle reeducation often is necessary to teach the patient to use the muscles of the legs and feet. Marked progress is made when the patient learns to contract and use the individual muscles. Weight-bearing exercises such as rocking the

weight forward to the balls of the feet reduce sensitiveness of the metatarsal area and aid in giving the patient confidence in shifting his weight forward, thus correcting the characteristic gait with the weight centered on the heels.

Experiments demonstrated that bicycling appears to be contraindicated during the subacute stage of this condition. This conclusion was made because in this type of exercise, the blood is carried to the large muscle groups and away from the distal segments of the extremities, where the blood supply is already diminished. However, in the late convalescent period bicycling is effective in increasing endurance and strength of the large muscle groups. Exercise and the patient's interest in improving his own condition are of primary importance in the subacute stage. Daily walks of graduated distances are beneficial in increasing endurance and muscle tone, and improving gait and posture.

Massage accompanied by passive stretching and active exercise produced the most effective results. However, several other modalities were used both in conjunction with the above and separately. It is difficult to evaluate the degree of benefit derived from the use of different forms of treatment or combinations of them.

The following modalities have been used: Whirlpool treatment given at ninety-two degrees Fahrenheit has been favored by some physicians as an aid in relieving the pain and increasing the collaterial circulation. If the water is too hot, pain and swelling are increased. Contrast baths with water at eighty and ninety degrees Fahrenheit appeared more stimulating in some cases than the warm whirlpool baths. If the temperature cannot be regulated correctly, the treatment is contraindicated. In some gangrenous cases, whirlpool has been used successfully in preoperative skin grafts to help cleanse the open lesions and to stimulate growth of granulation tissues.

Mecholyl iontophoresis has been used in both preoperative and postoperative cases, where gangrenous or open lesions are present on the toes and feet. Following the treatment, there is a noted vasodilatation in the part manifested by a pinkness in color and a warmness of the skin where the mecholyl-saturated gauze was removed. Ultraviolet radiation has been used to stimulate healing and as a bactericidal agent.

Diathermy to the lumbar region to induce reflex vasodilatation in the feet is another method used in attempting to establish a more nearly normal circulation. The Pavaex boot, designed to increase circulation in the extremities, was another device used. No appreciable improvement was noted from the use of these last two forms of treatment.

Much of the patient's progress depends upon the individual's willingness to cooperate in the physical therapy program and his application of personal and mental hygiene. Explicit directions are given the patients on the wards concerning the care which will shorten the convalescent period. The four things stressed are as follows:

1. Stop smoking.
2. Do not worry.
3. Keep warm and avoid chilling.
4. Exercise.

Tobacco in any form causes the muscles of the vessel walls to contract and diminish circulation. Worry also causes spasm of the blood vessels. Often patients worry about their prognosis, when they will be granted a furlough, and why they cannot be transferred nearer home. When it is explained to them that trench foot has never presented a serious postwar problem, and that with their cooperation, the period of hospitalization can be shortened, they adopt more favorable attitudes. Mental and manual activities are stressed as the best cure for worry—reading, writing letters, and taking full advantage of the occupational therapy and Red Cross programs.

Heat dilates blood vessels—cold constricts them. Feet should be kept covered and not exposed to drafts. Hot tub baths, in which feet are not immersed, are excellent in inducing reflex stimulation of circulation to extremities. Wool socks should be worn both day and night. It is necessary that they be kept clean and dry by frequent changes. If the feet are too sensitive to tolerate socks all day, they should be worn for shorter periods of time. The patient should never walk on the floor without socks or slippers. Shoes should be worn as soon as they can be tolerated. The exercises should be repeated frequently during the day and numerous short walks should be taken.

The majority of these patients on arrival at Brooke General Hospital were ambulatory and were given a period of physical therapy until they could walk approximately a mile, at which time they were sent on furlough. Upon returning from furlough, they were either sent to the convalescent hospital for observation, further physical therapy and physical reconditioning, or brought back to the general hospital for further treatment. There were approximately one hundred patients with some degree of gangrene due to trench foot, which necessitated surgical treatment.

In conjunction with the physical measures which have beeen described, medical and surgical

measures were employed. Medical measures such as whiskey and intravenous typhoid injections were administered in certain cases to promote vasodilatation. Surgical measures consisted of excision of gangreneous tissue after a well marked line of demarcation had formed. Subsequently, some of these patients had skin grafts and others required additional operative measures for removal of sequestra and draining sinuses.

In addition to the above measures, a clinical study of trench foot was carried out. Skin temperature studies were made to evaluate the efficiency of various forms of treatment. They showed that with the passage of time, regardless of the method of treatment, skin temperature of the toes gradually increased.

A study of the effect of sympathectomies was also made. Doctor Hansen makes the following statement in this regard: "Lumbar sympathetic block, spinal, caudal, and epidural, all revealed immediate temperature rises in the extremities. This was due to the inhibition of the vasoconstrictor nerves to the extremities, thereby allowing a greater flow through the vascular bed of the part. There were no permanent therapeutic benefits from this procedure. However, some patients stated that they felt better after the treatment. Few lumbar sympathectomies were performed since we found no permanent benefits resulting from lumbar sympathetic blocks."

Corrective orthopedic shoes with transverse and longitudinal arch supports were given to most of the patients. In cases of partial amputation of the foot, sponge rubber inserts were used to fill the empty portion of the shoes.

The majority of the trench foot patients received Certificates of Disability Discharge with some degree of compensation following a period of from three to four months hospitalization. Upon discharge, the patient was encouraged to carry out the instructions previously given him on the care of his feet, emphasizing wearing clean dry socks, keeping the feet warm, and continuing the foot exercises.

### *Conclusions*

Medical officers who worked with trench foot at Brooke Army Medical Center stated that they were convinced that physical therapy was the best measure available in treating these cases. In evaluating the different measures used, Doctor Hansen states: "In regard to the various physical therapy modalities used in the treatment of trench foot, the most outstanding ones found were:

1. Gentle passive foot motion and massage.
2. Corrective walking exercises.
3. Warm whirlpool baths."

The objectives set up have not been reached in each case, although marked improvement has been noted in all cases. Physical therapy alone cannot take credit for this improvement, but it has established a place for itself in the treatment of trench foot after the acute stage has passed.

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## Reprints Available

Reprints and pamphlets as listed below may be obtained from the following organizations:

*American Physiotherapy Association, 1790 Broadway, New York 19, N. Y.:*

"A History of the American Physiotherapy Association" by Ida M. Hazenhyer. (Price, 50c)

"Physical Therapy: A Service and a Career." (Free)

"Proceedings of Poliomyelitis Round Table from 1944 Conference." (Price, 10c)

"Nursing and Physical Therapy Responsibilities in the Hospital Care of Patients With Infantile Paralysis." (Free)

"You Can Get Well Faster," by Drs. Donald and Nila Covalt. (Free)

"Physical Therapy" by Mildred Elson.

"Financial Aspects of a Physical Therapy Department" by Harold Dean.

"Long Range Insurance for all General Hospitals —The Department of Physical Medicine" by Jessie Wright, M.D.

"Lasting Deformity can be Minimized by Muscle Conservation" by John A. Toomey, M.D.

"Polio Emergency Brings Nursing Service Special Responsibilities" by Lois Olmsted.

"Physical Therapy Procedures Used in the Preoperative and Postoperative Care of Chest Surgery Patients," by Ora L. Huddleston, M.D., Roberta Winston and Miriam Engelland. (Free)

*(Continued on page 304)*

# The Influence of Heavy Resistance Exercise on Strength

Sara Jane Houtz, Annie M. Parrish and F. A. Hellebrandt

Weight lifting recently has attracted attention as an adaptable form of therapeutic exercise. In 1945 DeLorme developed a program of heavy resistance, low repetition exercise at Gardiner General Hospital, which is based essentially on the technic of weight lifting.[1] This was effectively utilized for the restoration of muscle strength in young adult males suffering from service connected traumatic lesions of the bones, joints and surrounding tissues.

Weight lifting is a relatively little known sport in this country, although practiced on a world-wide scale. The lifts used in international competition have been well standardized. Weight lifting is pursued principally by those interested in the acquisition of great strength *per se*, as an adjunct to training in other sports, or by those who desire to improve the muscular component of physique. Over a period of years the various exponents of the art of weight lifting have arrived empirically at several training programs which apparently produce optimum increase in muscle size and strength. They may be characterized as follows: (1) systematic training with a load so heavy as to preclude the performance of more than 10-15 successive contractions; (2) progressive increase in the resistance offered to contraction as soon as the load selected can be lifted with facility more than 10 consecutive times; (3) periodic attempts to surpass the maximum work performed previously, and (4) the judicious introduction of rest days into the training routine, usually preceding and following the so-called "limit day."[2]

DeLorme's program of heavy resistance, low repetition therapeutic exercise is similar to the procedures established by weight lifters in all features of physiological importance, except the spacing of rest days. Institutional practices relative to the scheduling of patients made it necessary for the limit day to fall at the end of the week and to be followed by two nonexercise days, during which ambulatory patients were free to leave the hospital. In all other respects, the principles of weight lifting were painstakingly adapted to a variety of pathological conditions, and special equipment was devised to attain highly selective types of therapeutic exercise.

This study was undertaken because of the empiric origin and nature of the training regime employed. Its object was to evaluate DeLorme's technic of applying heavy resistance, low repetition exercise, by observing the response of normal subjects to such a program.

## Mode of Procedure

The subjects of the investigation were sixteen healthy females, varying in age from 25 to 48, in height from 1.52 to 1.75 meters, and in weight from 44.5 to 84.2 kilograms. All were engaged in nonsedentary work, and no control was exercised over general living habits. Six had received professional training in physical education, and eight were or had been affiliated with the armed forces. Work was performed always at approximately the same time of day. Following DeLorme's procedure, the subjects exercised daily Monday through Friday, while Saturday and Sunday were rest days. On the initial day of exercise, the procedure was explained and the work objectives for the following days were determined. Thereafter, every Friday was designated the limit day.

The initial observations were restricted to heavy resistance exercise of the quadriceps. This consisted of full extension at the knee joint, with the leg of the sitting subject carrying a variable load composed of an iron boot, to which adjustable weights are added. Quadriceps training was soon discontinued because knee joint pain of indeterminate significance developed in every subject. As a precautionary measure a smaller muscle group was substituted, with an end-point of power sufficiently below the margin of structural safety of the joint crossed, to protect the anatomical parts from possible damage. The activity selected for the major observations of this study demanded minimum skill, and was the fundamental lift known as the right or left hand curl.[3] It consists of grasping an adjustable iron

Baruch Center of Physical Medicine, Medical College of Virginia, Richmond, Va.

dumbbell in the hand, with the forearm in strong supination, the elbow in full extension, and the arm slightly flexed and adducted so as to occupy an unsupported starting position approximately 20 degrees in front of the body. The hand is brought slowly and steadily toward the shoulder joint of the homolateral side, until elbow flexion is complete. The movement is then reversed. Extension is controlled and performed at about the same rate as flexion. In the official lift, the trunk must not be tilted forward, backward or sideward, the shoulders must be kept level, the knees straight and the heels together. Since the sole objective of the program was the development of power, no effort was made to control form rigidly, or to maintain strict localization, especially during the performance of unilateral exercise with very heavy weights. The shift in the location of the center of gravity of the body as a whole thus induced is more easily equilibrated if the subject is allowed to assume a comfortably wide base, asymmetric if necessary. The load could be varied by minimal increments of 1.136 kgms.

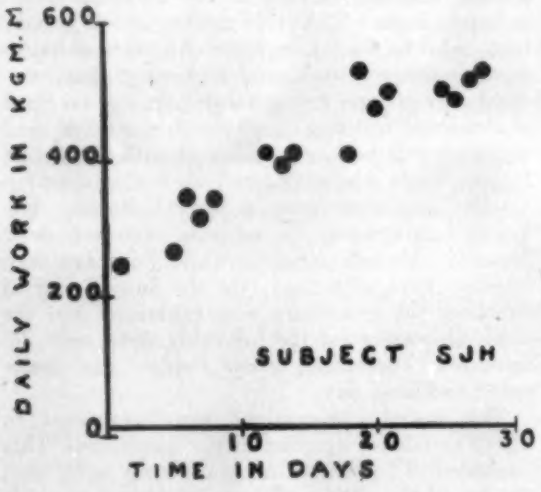


*Figure 1. Typical training curve for the right hand curl. The training procedure was reversed on the 6th, 8th, 10th and 12th exercise days.*

On the initial exercise day and each succeeding limit day, two criteria of muscle strength were determined. These are called by DeLorme the ten repetition maximum (10 RM) and the one repetition maximum (1 RM). Commencing with an arbitrary starting resistance, the subject performs bouts of 10 successive contractions with increasingly heavy loads until the heaviest weight that can be lifted 10 times is determined. The resistance to contraction then continues to be increased systematically until it becomes so great that the load cannot be lifted more than once. Neither the rhythm of the exercise nor the duration of the rest pause between bouts was standardized. Heavy resistance exercise, carefully performed, must perforce be done slowly.

The daily work unit consisted of 70 to 100 contractions divided into bouts of 10, with rest pauses interposed between each series of repetitions. DeLorme recommends that the final 20-30 contractions be performed against a resistance equal to but never surpassing the 10 RM. The subject likewise never performs more than 10 bouts of 10 contractions each. If the subject was unable to complete 10 contractions, the bout was discontinued and a rest taken before attempting the next bout. To further standardize the procedure, the subjects of this investigation began their daily training with a load not less than 50 per cent of the 10 RM of the last limit day, and the day by day goal was to carry the 10 RM for as many bouts as possible, rather than only during the last 20-30 contractions. A few subjects reversed the training procedure on alter-

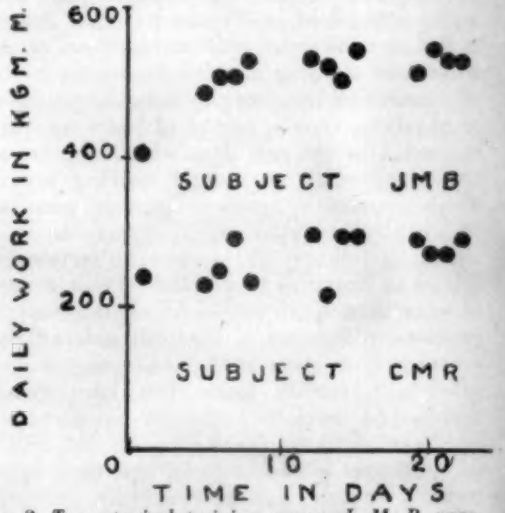


*Figure 2. Two atypical training curves. J. M. B. practiced the hand curl on the right; C. M. R. on the left.*

nate days, commencing with the 10 RM and reducing the load as it became too heavy.

To provide an alternate criterion by which to estimate improvement in muscle power, Martin's strength test was applied to the elbow joint flexors and extensors.[4] This measures the ability to resist a steady force applied at a standardized starting position to a specified point at right angles to the lever actuated by the muscle group being tested. It is similar in principle to manual

muscle testing, but strength is measured in objective rather than subjective units; that is, the kilograms of pulling force resisted by maximal muscular contraction.

The period of training covered approximately four weeks per subject in so far as the response is promptly measurable, and the use of such technics rarely exceeds this time limit in the average clinical case uncomplicated by restriction in the range of motion. The data collected were recorded in kilogram-meters of work done per bout and per diem. In toto, 270 experiments were performed.

## Results and Their Interpretation

The work done per day increased with the irregularity which characterizes the typical motor learning curve. Fluctuations in daily work output bore no apparent relation to factors in daily living which might be expected to affect strength. The margin of safety under which organ systems function is sufficiently large to compensate autonomously for fatigue when the work to be done stimulates interest. It was observed repeatedly that when the will to perform is great, exceptional achievement may be attained on days when the subject is tired and suffering from joint pain or muscle soreness. Figure 1 illustrates the irregular character of the average training curve. The trend is roughly linear. There is no evidence of decrease in the rate of gain in power during the initial three weeks of exercise.

Figure 2 (J. M. B.) demonstrates the phenomenon of diminished acceleration in the progress of learning. The improvement of J. M. B. was at first sharp, but soon leveled off so that in the fourth week of training, there was no apparent augmentation in the ability to do work. This record is exceptional, in that the initial capacity for work was greater than that exhibited by any other subject. The majority attained a terminal daily work output equivalent to that demonstrated at the peak of training by J. M. B. but none exceeded it.

Only one subject (C. M. R., Fig. 2) made no appreciable gain in strength during the four week period of exercise. She appeared to be putting forth good effort and was in all respects a cooperative subject. The results, however, indicate that in C. M. R. the concept of fatigue which determined the end-point of effort did not permit sufficient work to be done to induce the physiological changes associated with training. These occur only when the contractile elements are subjected to overload, which in turn calls forth maximal physiological effort.

When the two atypical cases (J. M. B. and C. M. R., Fig. 2) are removed from the group, the composite data obtained on the remainder show homogeniety in the general character of the response. This is illustrated in Figure 3. There is no marked deceleration in the gradient of a short time training curve. The average gain in strength made by normal healthy subjects in 20 days of heavy resistance, low repetition exercise covering a span of one month was 62 per cent, ranging from 5.3 to 137 per cent.

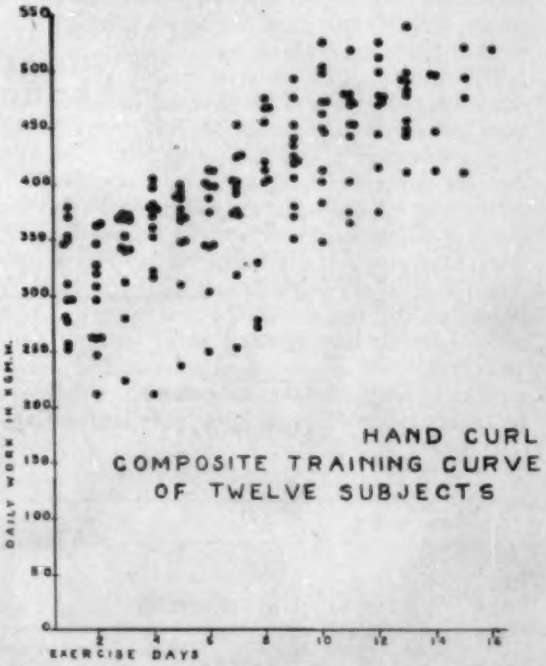


*Figure 3. The improvement in power is not graphed against time. The subject performed the daily exercise bout on the first four days of every week. The fifth day was the limit day. The sixth and seventh days were rest days. The total work done in consecutive work days is illustrated in the graph.*

Invariably more work was done per diem when the exercise procedure was reversed, commencing with the maximum load to be lifted (10 RM) and decreasing with the development of fatigue. This was an unexpected finding. It eliminates two uncontrollable variables in DeLorme's procedure, the arbitrary selection of a starting load, and uncertainty in gauging the gradient of the severity of the daily work output.

The physiological changes which occur during training and result in an increased capacity to do work are usually considered to be transitory adaptations which regress rapidly with the cessation of exercise. Figure 4 illustrates that

improvement in the ability to execute simple activities like the hand curl or knee joint extension is retained for an appreciable time, even though systematic training of the extremity is discontinued. Resumption of activity weeks after an initial training period which was in itself very short, is associated either with negligible loss or actual gain in the ability to do work. a uniaxial joint. How much of the gain in strength demonstrated in these experiments on normal subjects is due to hypertrophy of muscle, how much to improvement of the specific microscopic structure of the contractile tissue, and how much to changes of an unexplained nature occurring in the central nervous system is open to speculation. Morphological, biophysical and

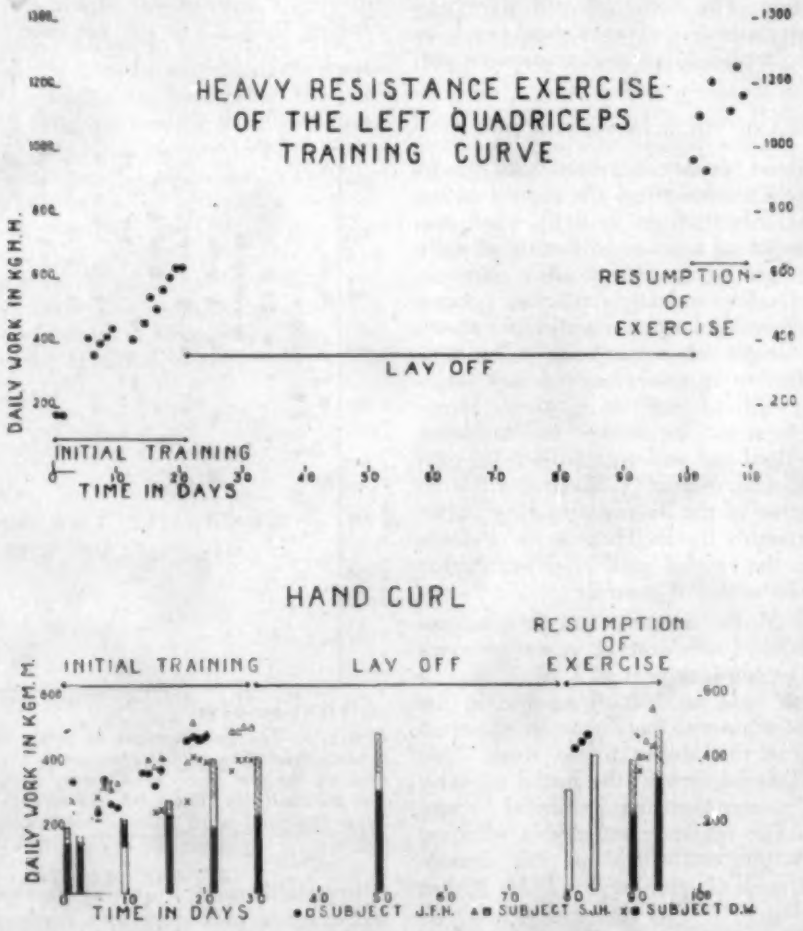


*Figure 4. Unilateral training of the quadriceps was discontinued after three weeks because of disabling knee joint pain. Recovery was spontaneous. Between the 23rd and 37th days, the subject performed bilateral knee joint extension against heavy resistance carrying approximately twice and then three times the 10 RM lifted by the left quadriceps alone. No other leg exercises were performed from the 37th day to the time unilateral training was resumed on the 102nd day. The columns represent total work done on limit days.*

Paradoxically, the subject might continue to improve in the ability to contract against heavy resistance during a prolonged lay-off from systematic daily training. This finding emphasizes the unequivocal importance of motor learning in activities as simple as flexion or extension of physiological changes probably take place concurrently during training.

The responsiveness of the subject to psychic stimulation and his desire to excell previous records were found to be variables of dominant importance. Nothing in the technic of applying

heavy resistance, low repetition exercise guarantees a physiological rather than a psychological end-point of effort. The evidence obtained from observing normal subjects indicates that the most important element in augmenting daily work output is the will to put forth an all-out effort. As the intelligently cooperative subject becomes enured to the discomfort invariably associated with the lifting of weights heavy enough to tax strength, the power to contract may extend so rapidly as to invalidate any hypothesis which attributes this phenomenon to morphological change in the contractile elements which compose muscle. A modification in the intellectual concept of maximal capacity is sufficient to significantly augment work output. Because weight lifting so readily lends itself to the erection of simple, self-competitive objective goals, the disrupting effect of this important variable is held somewhat in abeyance. Much obviously depends on the ability of the physical therapist administering the heavy resistance exercise program to instill in the patient the will to extend the severity of the daily work bout whenever the objective of therapy is improvement in strength. It cannot be overemphasized that no augmentation in muscular power *per se* will occur when the amount of work done per unit of time falls easily within the functional capacity of the groups being treated.

Muscle soreness never occurred during the training of the quadriceps. The limiting factor was invariably knee joint pain. Thus, the potential strength of this large muscle mass exceeds, in normal subjects, the ability of the joint structures to withstand microtrauma. Elbow joint pain occurred only in one of the 16 subjects who performed the hand curl. This was limited to the region of the medial condyle of the humerus and was apparent only on palpation. One subject who exercised with exceptional vigor, reported paresthesias in the ulnar distribution when very heavy weights were carried. Thus, the potential hazards of heavy resistance exercise involve various anatomical structures contiguous to the parts undergoing treatment.

There was a poor correlation between the two criteria of improvement provided by this study. Manual muscle testing, which measures a single maximal effort, showed much less gain with training than the limit day or work per diem criteria, and the gain was notably larger for extension than flexion. These findings are summarized in Table 1. Manual muscle testing is a notoriously unreliable measure of physiological function, lending itself better to general reinforcement of

*Table I*

| SUBJECT | MARTIN'S STRENGTH TEST | | | | | | | | LIMIT DAY | | | | WORK PER DIEM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FLEXION | | | | EXTENSION | | | | | | | | | | | |
| | I | F | Difference Ab. | % | I | F | Difference Ab. | % | I | F | Difference Ab. | % | Maximum | Minimum | Difference Ab. | % |
| | kgs. | kgs. | kgs. | | kgs. | kgs. | kgs. | | kgs/s | kgs/s | kgs/s | | kgs/s | kgs/s | kgs/s | |
| F. A. H. | 26.4 | 21.8 | -4.4 | -16.8 | 16.8 | 20.9 | +4.4 | +26.6 | 297.3 | 794.0 | 96.7 | 325.3 | 514.6 | 537.3 | 222.7 | 70.8 |
| | | | | | | | | | 84.4 | 189.7 | 115.3 | 156.6 | 288.0 | 519.8 | 231.8 | 80.5 |
| J. H. B. | 25.0 | 23.6 | -1.4 | - 5.6 | 18.2 | 16.4 | -1.8 | - 9.8 | 236.1 | 361.7 | 96.6 | 37.3 | 527.5 | 418.7 | 108.8 | 20.6 |
| | | | | | | | | | | (418.7) | (167.6) | (61.5) | | | | |
| S. J. H. | 25.8 | 30.2 | +2.7 | +10.5 | 14.8 | 18.2 | +3.4 | +22.9 | 212.4 | 418.0 | 206.6 | 97.3 | 288.8 | 223.5 | 205.3 | 57.6 |
| | | | | | | | | | | (490.2) | (277.8) | (130.8) | | | | |
| F. C. | 25.0 | 24.0 | -1.0 | - 4.0 | 13.6 | 14.5 | +0.9 | + 6.6 | 131.7 | 270.2 | 138.5 | 105.2 | 539.0 | 252.4 | 286.6 | 53.2 |
| | | | | | | | | | | (274.9) | (143.2) | (108.7) | | | | |
| E. K. | 26.0 | 23.1 | -1.9 | - 7.6 | 16.0 | 19.2 | +3.2 | +21.5 | 198.2 | 236.8 | 37.6 | 19.0 | 457.1 | 213.4 | 243.7 | 53.5 |
| | | | | | | | | | | (260.6) | (62.4) | (31.5) | | | | |
| J. M. T. | 27.3 | 23.1 | -4.2 | -15.3 | 15.0 | 15.5 | +0.5 | + 3.3 | 196.1 | 252.0 | 53.9 | 27.2 | 469.0 | 346.3 | 122.7 | 26.1 |
| D. F. | 22.7 | 22.7 | 0 | 0 | 14.5 | 18.2 | +3.7 | +25.5 | 194.4 | 279.4 | 85.0 | 43.7 | 514.8 | 365.8 | 149.0 | 28.9 |
| | | | | | | | | | | (429.0) | (234.6) | (120.7) | | | | |
| D. L. | 22.2 | 21.4 | -0.8 | - 3.6 | 9.6 | 11.4 | +1.8 | +18.7 | 188.6 | 353.8 | 165.2 | 87.6 | 476.8 | 298.7 | 178.1 | 37.4 |
| | | | | | | | | | | (332.6) | (144.0) | (76.4) | | | | |
| S. S. H. | 20.9 | 25.5 | +4.6 | +22.0 | 12.7 | 13.2 | +0.5 | + 3.9 | 221.3 | 233.0 | 11.7 | 5.3 | 427.0 | 341.0 | 86.0 | 20.1 |
| J. F. K. | 23.1 | 21.8 | -1.3 | - 5.6 | 13.6 | 11.9 | -1.7 | -12.5 | 167.4 | 297.2 | 129.8 | 77.5 | 463.9 | 367.8 | 216.1 | 46.7 |
| | | | | | | | | | | (371.8) | (204.4) | (122.1) | | | | |
| E. V. H. | 25.5 | 26.9 | +1.4 | + 5.4 | 15.4 | 15.5 | +0.9 | + 6.4 | 296.6 | 388.4 | 89.8 | 30.3 | 490.0 | 249.5 | 243.5 | 49.7 |
| | | | | | | | | | | (404.6) | (108.0) | (36.4) | | | | |
| C. H. R. | 21.8 | 20.0 | -1.8 | - 8.3 | 14.5 | 14.0 | -0.5 | - 3.4 | 114.9 | 250.2 | 135.3 | 117.8 | 296.5 | 224.4 | 61.9 | 20.9 |
| | | | | | | | | | | (264.7) | (139.8) | (121.7) | | | | |
| D. W. | 22.7 | 22.2 | -0.5 | 0 | 14.5 | 14.5 | 0 | 0 | 187.1 | 237.8 | 80.4 | 51.2 | 419.0 | 249.0 | 170.0 | 40.6 |
| | | | | | | | | | | (316.0) | (188.9) | (101.1) | | | | |
| M. K. G. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 134.3 | 176.0 | 417.0 | 31.1 | 490.7 | 276.6 | 214.1 | 43.6 |

* Elbow joint flexion and extension
I Initial trial
F Final trial
Ab. Absolute
** Hand curl
( ) Retest limit day data 8 to 10 days after termination of training

clinical impressions of improvement, rather than to quantitative studies of variations in muscle strength.

Limit day data provide a criterion of improvement which can be made more reliable by simple modification in procedure. The amount of work done on the limit day is dependent not only on how heavy a load can be lifted, but also on the total number of lifts attempted. To be maximally comparable, the load lifted during the initial bout of 10 contractions on each limit day should be uniform throughout the training period, increasing by predetermined increments during each succeeding bout. As the subjects of this study grew stronger, the initial load lifted on the limit day was inadvertently advanced. Unfortunately, the starting point arbitrarily selected by the subject bore no uniform relation to either the 10 RM or the 1 RM of the preceding week.

Since the limit day sets the work goal for the succeeding week, it becomes a factor of crucial importance in the training regime. The subject with the stamina to push total work done on the limit day significantly beyond maxima previously attained, exercises with the greatest overload in the succeeding week, and may thus be expected to reach the highest levels of improvement in strength.

## SUMMARY AND CONCLUSIONS

The influence of heavy resistance, low repetition exercise on the muscle strength of 16 healthy females was studied during a weekly program of four exercise days, one limit day, and two days of rest. The quadriceps lift and the right or left hand curl were practiced, and, as muscle strength and skill improved, weight gradients were increased conforming to the prototype set by the limit day. The two criteria of muscle strength determined on the limit day were the maximum weight the subject could lift successively 10 times and the maximal load lifted once. The evidence presented supports the following conclusions:

1. The most important single element in the intensification of the daily volitional work output is the will to perform a physiologically maximal effort.

2. Augmentation in strength through daily exercise is associated with a significant increase in the work done on the limit day.

3. The rate of improvement in work capacity is rapid under a program of heavy resistance exercise.

4. Strength may more than double in four weeks of systematic training.

5. If the muscle group exercised is large, the increase in power may exceed the ability of contiguous joint structures to withstand the stresses to which they are subjected.

6. There was no relationship between pre- and post-training strength measured by a single effort manual muscle test and the limit day criteria.

7. There is no evidence of significant loss in the kind of increase in work capacity which is acquired by heavy resistance exercise, during a postexercise period which exceeds in duration, the initial period of training.

8. The ability to perform work may continue to improve after the cessation of systematic training. This phenomenon suggests changes of an unexplained kind associated with motor learning, among which must be included significant extension of the psychological end-point of fatigue.

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## Reprints Available

*(Continued from page 294)*

*Joint Orthopedic Nursing Advisory Service, 1790 Broadway, New York 19, N. Y.:*

"Improvised Equipment for the Physically Handicapped (1944)," by Margaret S. Arey. (Free)

"Hemiplegia" by William Bierman, and "Nursing Care in Hemiplegia" by Anne Prochazka.

"Nursing and Physical Therapy Consultation in State Crippled Children's Program" by Florence L. Phenix.

"An Orthopedic Service for the Community" by Jessie L. Stevenson.

*National Foundation for Infantile Paralysis, 120 Broadway, New York 5, N. Y.:*

Muscle Charts for Poliomyelitis. (Available in any quantity.)

*Institute for the Crippled and Disabled, 400 First Avenue, New York 10, N. Y.:*

"The Challenge of Crutches" by George D. Deaver and Mary Eleanor Brown. (Price, 50c)

# Present Trends in Physical Medicine

George Morris Piersol, M.D.

This article was not written by one versed in physical medicine as the result of years of long experience and extensive practice in this field, but by one whose tradition and training, having been in clinical medicine, has found himself during the past few years intensively exposed to various aspects of physical medicine at an exceptionally interesting and critical period. Such comments as follows, therefore, inevitably reflect the viewpoint of the physician rather than that of the trained physical therapist. Nevertheless, they may be of some interest as representing certain impressions obtained from observing present trends in the teaching and practice of physical medicine.

The last five years have witnessed unprecedented development in every aspect of physical therapy and occupational therapy. These two divisions of physical medicine are purposely referred to together, since in modern practice they are inseparably interrelated. The causes that are responsible for recent progress in physical medicine are not far to seek and are: (1) The war with its casualties—the urgent necessity of returning as many fighting men as possible to the firing line in a short period of time, and hence the pressing need for an immediately effective reconditioning program. (2) A sharp rise in the incidence of industrial accidents due to the large numbers employed, the speed and tension under which work had to be done, and the relatively high percentage of poorly trained and unskilled workers. In order to maintain the high rate of production, these injured workers also had to be returned promptly to their jobs. (3) The widespread publicity given physical medicine along with the stimulus, in the form of educational opportunities and material assistance, furnished by the National Foundation for Infantile Paralysis, the Baruch Committee, and similar organizations. As a consequence of the above mentioned factors, in this country more people than ever before have acquired an interest in physical therapy and occupational therapy, have sought to take up these callings, and have come to look upon them as highly desirable and constructive forms of occupation.

The thought has been expressed that with the cessation of hostilities and the advent of peace there would occur a sharp decline in the demand for physical medicine. Although, happily, the destructive aspects of war apparently are over, there is nothing to indicate a diminishing need for physical therapy either in the immediate or distant future. For at least another generation the problem of rehabilitation within the Veterans' Administration alone is destined to tax our ability to produce enough adequately trained physical and occupational therapists to meet the demand. Even though, within the next few years, the predicted decrease takes place in the number of disabled veterans suffering from amputations, peripheral nerve injuries, lesions of the brain and spinal cord, and deformities, the result of fractures, wounds, burns, etc., who now require constant treatment, their places will be taken by additional thousands of service men and women suffering from arthritis, vascular and other degenerating diseases, and neuropsychiatric conditions. These will continue to demand physical therapy.

Even if the entire rehabilitation load presented by the Veterans' Administration could be eliminated, there will still remain the ever present problems of industrial accidents and disabilities. One is apt to lose sight of the fact that in a nation such as ours, largely occupied in manufacturing, construction, transportation, mining, and agricultural pursuits, the annual toll of industrial injury, not including traffic accidents, is far in excess of the battle casualties of any war. It is stated, for example, that in any one year civilian and industrial catastrophies are responsible for more amputations than the combined number of amputations performed in all of our armed forces during this past war. If to this industrial group are added the steady increment

University Hospital, Philadelphia, Pennsylvania.

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of victims of poliomyelitis and the cerebral palsies, it is obvious that as a nation we are and always will be faced with the demand for qualified physical and occupational therapists that for years to come will far exceed the available supply. In recognition of this situation the National Foundation for Infantile Paralysis has launched an effective campaign to recruit physical therapists and train instructors. Thus, there is small reason to fear any lack of opportunity in these fields of therapy.

A few years ago the most sanguine and ardent advocates of physical medicine could not have invisioned the undreamed of expansion which we have seen take place in this field. The immediate problem is whether the momentum which has been imparted to physical medicine can be maintained, or whether it is to be allowed to die down. If the future progress in physical medicine lags, it will not be for lack of need, which confronts us on all sides, but rather because those of us concerned in this subject have failed to realize our obligation and effectively to take advantage of the opportunity which today knocks so loudly at our door.

The main factor that must be depended upon for the further and continued development of physical medicine may be expressed in the single word "*Education.*" To be successful, education will have to be carried out simultaneously along four lines, namely: (1) The better training and more adequate education of physical therapists. (2) The increased education of more physicians both as to the need for and the value of physical medicine in the treatment of injuries and disease. (3) The creation of a wider demand for and a better understanding of physical medicine among the laity, as well as in various professional groups. (4) The fostering and developing of the basic physiological research along with clinical research in physical medicine.

It is but natural that your greatest interest centers about the first of these lines of approach. The last few years have seen many long needed improvements in the educational program for physical therapists. Although much has been accomplished, still more remains to be done. Under the thoughtful guidance of the Council on Medical Education and Hospitals and the Council on Physical Medicine of the American Medical Association in conjunction with the American Physiotherapy Association, the curricula in our schools for the training of physical therapists have gradually been revised upwards. Standards have been established by which it is now possible to appraise the educational efficiency of schools so that those which meet the necessary qualifications may be approved. As the result of this policy a group of approved schools now exists wherein students may receive adequate, properly supervised training in physical medicine and graduation from which is a prerequisite for admission to the American Physiotherapy Association and to the examinations held periodically by the American Registry for Physical Therapy Technicians.

In order to profit from such an approved course of instruction it is essential that prior to admission students should have successfully completed a prescribed course of preliminary education. The prerequisites for admission to approved schools of physical therapy and occupational therapy should be well known to you and are so clearly set forth in various publications, including those of the American Medical Association, that it is superfluous to restate them at this time. They should be familiar to all who advise those who aspire to follow a career in physical medicine so that those whose educational qualifications are inadequate will be discouraged from presenting themselves for admission. If such a policy was more carefully followed, much disappointment and many misunderstandings would be avoided. As the demand for training in physical medicine increases and the educational background of applicants for admission to our schools improves, it is but natural that the directors and technical directors of approved institutions should exercise greater discrimination in their selection of students. It is probable, therefore, that the day is not far distant when the only acceptable applicants will be degree nurses, or those with college educations that embody adequate training in the biological sciences. This situation may arise even before such requirements are officially demanded. There is little doubt but that in the near future the length of undergraduate courses for physical therapists will have to be increased, if our students are to keep pace with the expanding knowledge in this field. All who are sincerely desirous of seeing physical medicine placed upon a sound scientific basis look upon this uptrend in education with satisfaction and rightly regard this tendency as a healthy sign. There are those, however, who contemplate this steady increase in educational requirements with some degree of skepticism and apprehension. They contend that there is danger of the pendulum swinging too far and that by raising academic standards too high many desirable applicants, who possess good potentialities for physical medicine, will in their

discouragement be diverted into unapproved schools and may even be driven to embrace some of the numerous so-called cults. Furthermore, elevation of educational standards and increased time devoted to education inevitably leave in their wake economic problems involved in higher salary adjustments. It is doubtful whether such fears are well founded and whether they should be allowed to interfere with the wholesome educational program which is so well under way.

A plan which will effectively curb the activities of inferior schools and lessen the opportunities for unqualified physical therapists is the setting up of licensing boards in every state of the Union, a plan that for some years has been in successful operation in the State of Pennsylvania. At present there are only five states that require the licensure of physical therapists by examinations that are open only to candidates that have graduated from schools approved by their state. With the majority of our states not insisting upon examinations and the approval of schools of physical therapy, it is at present possible for psysical therapists, regardless of their training, to practice almost anywhere in the United States. So long as such a situation exists, unapproved schools will continue to flourish, and many unqualified persons will practice physical therapy. The remedy for this unfortunate state of affairs is not easy; it cannot be brought about quickly by either prosecution or persecution. It requires patience, forbearance, and the slow, orderly process of education. As the educational qualifications of those who enter upon the career of physical medicine are gradually raised, and as the field is slowly dominated by an ever increasing number of registered physical therapists, the present situation will, in the course of time, be relieved. This goal, however, cannot be attained by revolution; it can be brought about only by evolution.

The further advancement of physical medicine depends in no small degree upon the education of physicians. As has often been pointed out, undergraduate instruction in physical medicine in nearly all of our medical schools is either totally lacking or woefully inadequate. Until this situation is remedied, physicians will continue to enter upon the practice of medicine unprepared in even the basic principles of this time-honored and important therapeutic field. It is encouraging to note that each year greater interest is being taken in undergraduate instruction in physical medicine. Instruction in this subject should not cease with a perfunctory undergraduate course. It should be continued in our hospitals. Internes should be assigned for regular work in a department of physical medicine just as they are at present assigned to a clinical laboratory or a department of roentgenology. Just as residencies are offered in most of the clinical fields, so residencies should be made available in physical medicine. It is gratifying to note that steps in this direction are already being taken in some institutions, and within the last few weeks a half dozen large New York hospitals are offering to properly qualified physicians such residencies. This educational activity has received much encouragement and help from the Baruch Committee.

Probably the most fertile field for the education of doctors in physical medicine lies in our graduate medical schools. There are educators who maintain that physical medicine for physicians is a graduate rather than an undergraduate activity. Systematic, basic courses in physical medicine are now available in certain graduate schools. It is heartening to note that they are being taken advantage of by some of the medical officers returning from our armed forces, where many had an opportunity to observe the value of physical therapy. Such basic graduate training normally leads to fellowships in physical medicine, a number of which are now available in various parts of the country as the result of the foresight and generosity of several organizations, the National Foundation for Infantile Paralysis and the Baruch Committee in particular. A survey of the field of physical medicine makes it apparent that there is a crying need for trained physicians in this medical specialty. A department of physical medicine should be under the direction of a properly qualified physician. Today there are so few physicians available in this field that many desirable openings in hospitals that have or that desire to develop departments of physical medicine remain vacant.

Educational efforts directed to physicians should not be confined to the formal education of those who aspire to be specialists in physical medicine. Much greater effort should be put forth to instruct practicing physicians as a group in the value of physical medicine and the possibilities that are offered by this branch of therapy. Physicians should be made aware of the fact that physical medicine is an indispensable adjunct in the treatment of many conditions with which they are constantly confronted, notably, arthritis, fractures, and many orthopedic and neurological conditions. Physicians should be taught that satisfactory results are obtainable only when suit-

able technics are properly carried out, and that dependable service of this type can be expected only from the well trained, registered physical therapist. When there is a more widespread acceptance of this principle, fewer unqualified technicians will find favor with the medical profession. The result will be that treatments will be more effectively and successfully carried out, and some of the approbrium which has been heaped upon physical therapy because of its improper application will be lessened.

Suitable propaganda and educational efforts should not cease with physical therapists and physicians. An effort should be made to acquaint the public at large with what may be expected of properly controlled physical medicine. People should be made aware of the evils of entrusting such well established procedures to the irresponsible hands of inadequately trained individuals who are all too prone to exploit certain procedures for their own selfish ends and personal aggrandizement. Patients should be better informed as to just what physical medicine embraces and its value in the treatment of suitable conditions. Furthermore, it should be made clear to them that physical therapy should be carried out only under medical supervision and by responsible, registered physical therapists.

There should be a greater appreciation of the usefulness of physical forms of therapy in their widest application. Physicians, nurses, physical therapists, and patients alike should be made aware of the value of physical therapy to many bedridden patients. They should learn that its proper employment will do much to shorten convalescence and return patients to a state of self-reliant usefulness at a much earlier time than is at present often the case. It is not generally appreciated that proper posture and suitable exercise are but the everyday application of the principles of physical medicine. Much could be done to teach our nurses how to constantly utilize the simple technics of physical therapy in the routine management of the patients entrusted to their care. By the application of the principle of proper body mechanics, the health and the comfort of many a bedridden patient could be greatly improved. Normal muscle tone could be maintained and disfiguring and disabling contractures and deformities avoided. Examples of the way in which the period of bed rest can be lessened, convalescence materially shortened, have been forcibly brought to our attention by the programs of reeducation that have been so successfully carried out in many of our Army installations. The lessons thus learned might with advantage be extended to many of our civilian institutions.

In addition to education, if further progress is to be made in physical medicine, it must depend upon a well organized program of research. Observation of the problems presented in any department of physical medicine makes it evident that successful research can be carried out only by properly coordinated teamwork. In such a plan the efforts of the physical therapist and physician must be supplemented by the technical training of the physiologist, the biophysicist, and the physicist. It would be inappropriate to attempt to outline here the innumerable problems for investigation that present themselves. There is still much to be learned, not only as to how the various agencies employed in physical medicine act upon the organism, but what should be their proper dosage. The same form of approach that has placed drug therapy upon a sound scientific foundation must in the near future be applied to the various procedures that are used in physical medicine. Heretofore, too much has been left to empericism. Reports have been based too often upon uncontrolled clinical impressions. The time has now come when the whole field needs to be reviewed and evaluated from the standpoint of objective scientific observations.

If such coordinated efforts as above outlined can be developed and tireless emphasis placed upon education in its broadest sense, the recent gratifying advances that have been made in the field of physical medicine will be not only consolidated, but pushed constantly forward. When such a program is put into execution, we may contemplate with confidence the future of physical medicine and feel assured that it is destined to take its rightful place as a recognized medical specialty.

# Physical Therapy in the Treatment of Neurosurgical Conditions:

## *With Special Reference to New Electrodiagnostic Measures**

**Edna L. Dillon, 1st Lt., M.D.P.T., A.U.S.**

Early in 1943 the Percy Jones General Hospital at Battle Creek, Michigan, was designated as one of the neurosurgical centers of the United States Army. Shortly following this date, many battle casualties arrived among which were a large number of peripheral nerve injuries. Approximately 2,254 patients with nerve injuries have been treated at this hospital since that time.

With large numbers of patients to be treated and the shortage of space and trained personnel, it was advisable to establish efficient and routine physical therapy procedures. Since associated circulatory disturbances often occur in peripheral nerve injuries, it was believed that some form of heat and massage was indicated. Whirlpool was the modality of choice since it combined heat and massage with varying and controlled factors. In the event a contraindication for hydrotherapy existed, such as a skin condition, a draining lesion, an ununited fracture or a recent operation, infra-red and massage were administered.

Immediately following the whirlpool treatment, each patient received sinusoidal current stimulation to the muscles supplied by the involved nerve for a period of ten minutes. Since December 1944, however, this technic has been changed. At the present time each muscle receives stimulation with an interrupted galvanic current. The number of stimulations starting at three is increased daily up to thirty contractions or just short of the point of fatigue. Electrical stimulation is continued on each muscle until voluntary power returns. When the threshold current is extremely high, or when marked atrophy is present, opposing muscles will contract and the interrupted galvanic current is of little benefit. An exercise current such as a smooth galvanic sinusoidal current is then preferred.

All peripheral nerve patients receive reeducational exercise to the involved muscles. When a muscle has zero to ten per cent power it is carried through complete range of motion by the physical therapist, the patient attempting voluntary movement at the same time. This is given until the patient has evidenced four to five contractions in each involved muscle. As the strength of the muscle increases up to fifty per cent, the patient progresses to active assistive exercise, that is actively contracting the muscle to its fullest extent at which time the physical therapist assists in completing the range of motion. With a muscle having less than fifty per cent power, the patient attempts four to six active contractions. When this amount of power (fifty per cent) has been gained, exercise against gravity and resistance offered by the physical therapist is indicated. The remaining muscles of the extremity which are not innervated by the involved nerve receive active and resistive exercise using apparatus such as pulley weights, shoulder wheel, finger ladder, wand exercises and exercises on the Kanavel table.

A typical treatment schedule for a patient having a partial lesion of the brachial plexus (eleven months postneurorrhaphy) would be as follows:

a. Whirlpool to the entire extremity.
b. Infra-red and massage to the shoulder and upper arm.
c. Interrupted galvanic stimulation for those muscles which evidence no voluntary power.
d. An extensive exercise program including reeducational exercise to all of the involved muscles. The muscles of the upper arm and shoulder girdle which have greater than fifty per cent power would receive active and resistive exercises using apparatus such as the shoulder wheel for circumduction and pulleys for abduction, adduction, flexion, extension, inward and outward rotation. The Kanavel table for supination and pronation of the forearm, flexion and extension of the fingers and wrist would also be indicated.

Patients having weakness of finger flexors are further encouraged to use a rubber ball or sub-

Percy Jones General Hospital, Fort Custer, Mich.

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*Material in this article appeared in unpublished Instruction Manual entitled "Electro-diagnosis; Examination of Peripheral Nerve Lesions by Percutaneous Stimulation of Muscle," by Lt. Col. Frank H. Mayfield, M.C., Capt. Y. T. Oester, M.C., and the author.

stitute exercise to increase strength and flexibility. All patients are continually encouraged to exercise their extremities in addition to the treatment received in the Physical Therapy Section. It has been demonstrated that the individual with a peripheral nerve injury who has continued to use the part has a better functional recovery when the muscles once again become neurotized, atrophy is decreased, and circulation is improved.

Immobilization when indicated for the protection of weakened muscles or muscle groups is accomplished for the shoulder girdle with an abduction or aeroplane splint at approximately a seventy degree angle. A modified banjo splint as designed by Lt. Col. Frank H. Mayfield,[1] M.C., AUS, formerly assigned to Percy Jones General Hospital, is used in injuries to the radial nerve. This splint affords resistive exercise in flexion of the fingers against the pull of rubber bands, and maintains the wrist and fingers in a position of extension when at rest. In peroneal nerve injuries the involved muscles are protected from overstretching by a simple right angle spring brace. In those patients having severe contractures of the "web of the thumb," a modified opponens cuff which maintains the thumb in a position of abduction and opposition is used. As voluntary muscle power becomes apparent, the patient is allowed to decrease the amount of time during which the brace or splint is worn.

In addition to the already mentioned treatment, those patients who have joint limitation due either to vascular deficiencies or immobilization receive additional treatment in an attempt to overcome these joint restrictions. Some of the treatment includes a paraffin bath for one-half hour in duration preceding the exercise program or passive stretching with weights. Sodium chloride iontophoresis also has proven beneficial in cases when fibrotic ankylosis of joint capsules or when adherent scars have been slow to respond to routine therapy.

When a patient with a nerve injury is referred to the Physical Therapy Section a voluntary muscle check and a sensory test are routinely accomplished. In order to note progress, this procedure is repeated every six weeks. When feasible the patient is tested by the same physical therapist who previously performed the test, thus minimizing individual differences in checking.

Electrical testing also plays an important role in the evaluation of progress in the treatment for peripheral nerve injuries. Originally conventional faradic-galvanic tests to determine the so-called "reaction of degeneration" of the involved nerves and muscles were routinely employed. It soon became apparent to the surgeon, as well as those performing the test, that the information so obtained was inadequate. In order to obtain more helpful and reliable information it was therefore deemed necessary to seek another method of testing. This was accomplished through extensive clinical investigations carried out at the Percy Jones General Hospital since February 1944. There is no claim to originality for the work which was carried on in collaboration with and under the supervision of Doctors Pollock and Golseth and their associates at the Northwestern University Medical School. The major portion of the work was done under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and Northwestern University.

The present test has been used at the Percy Jones Hospital Center since February 1945. Many hundreds of tests have been accomplished and the value of the test has become evident. In October of last year a conference was held for the purpose of introducing this method of testing to representative neurosurgeons and physical therapists from other Army neurosurgical centers.

It has been observed that a muscle which has lost its nerve supply continues to be irritable to the galvanic current but that changes occur in the character of the contractions and the threshold current required. Furthermore, the amount of current required for contraction varies greatly, depending upon the duration of the stimulus and the interval between stimuli. Interpretation of these phenomena appear to be the key to sound electrical testing.

Contraction of muscles may be recognized by direct observation or palpation of muscle belly or tendon, or by movement of the part. Interpretation, however, depends upon the amount of current strength in milliamperes required to induce contraction. Therefore it was advisable to establish a certain fixed degree of contraction as a standard. *The minimal visible contraction was accepted as that standard.*

The speed of contraction varied somewhat depending upon the degree of neurotization of the muscle. It appeared advisable to grade contractions in four arbitrarily chosen categories based on the examiner's observation of speed and nature of contraction.

Grade 1 (+) is a slow "wormlike" contraction and is usually indicative of denervation.

Grade 2 (++) is also a slow contraction but

less "wormlike" in character than +, and may be seen either in early periods of recovery or in incomplete denervation.

Grade 3 (+++) is a slow twitch. The contraction occurs when the circuit is made but no sustained contraction is observed. Usually this appears to signify advanced degrees of neurotization.

Grade 4 (++++) is a more rapid and vigorous contraction. This state is demonstrated only in normal muscles.

The term "reaction of degeneration" describes a state of progressive change in muscle irritability after loss of all or part of its nerve supply. It has long been recognized that muscle is more easily stimulated for a short period of time after injury to its nerve. With the passage of time, it was believed that higher and higher thresholds of current were required to induce contraction, until eventually the muscle was no longer capable of contraction. At that period, absolute reaction of degeneration was said to have occurred. From this state, recovery was considered unlikely or impossible.

Pollock[2] and his associates have demonstrated by experimental specimens in cats that denervated muscle responds to less current than normal, and that the threshold becomes progressively less for approximately twenty to forty days, when it levels off and remains low throughout the denervated period. Certain specimens were observed for more than two hundred fifty days. Furthermore, they showed that the threshold required for contraction increased very abruptly after about ninety days in cases where the nerve was repaired. The change appears to occur when the axis cylinders reach the muscle (Fig. 1).

It early became apparent that electrical evidence of the presence of nerve fibers reaching a muscle might be found in cases in which no voluntary motion was present and in which clinical recovery did not subsequently take place. Therefore, the term "neurotization" was adopted in preference to recovery, denervation, etc. It follows, therefore, that one would not expect evidence of neurotization until sufficient time had elapsed for the fibers to reach the muscle being observed.

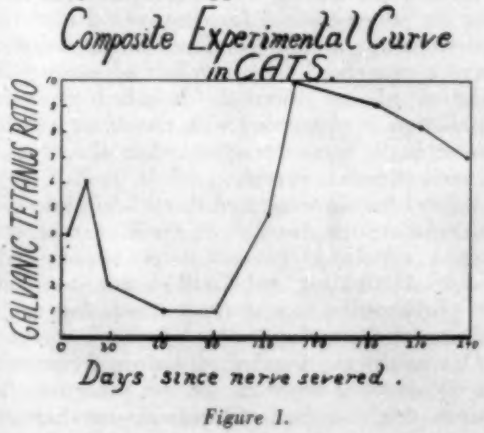


*Figure 1.*

With the progress of the investigation and the development of this new method of testing it was apparent that new and more efficient apparatus would be required. Following the plans of a new machine constructed at Northwestern University, by combining the resources of the physical and occupational therapy, and the educational reconditioning sections of the Percy Jones General Hospital, a number of machines were finally produced.

It was deemed necessary that an efficient testing machine should possess the following characteristics:

1. A steady monophasic current.
2. A delicate current strength measurement.
3. An accurate current strength measurement.
4. A polarity control switch.
5. A time control of duration of stimulus.
6. A time control of interval between stimuli.
7. A relatively painless current.
8. Stimulating electrodes of convenient design.

The control of interval between stimuli has been calibrated to include five arbitrary times ranging from one millisecond (.001 sec.) duration to four seconds. The first approaches a continuous current and the latter is sufficiently long to eliminate any summation effect.

The dial controlling duration of impulse covers a range from 0.001 seconds to 1.5 seconds. These limits are adequate for the determination of muscle chronaxie.

The milliameter is well damped, having minimal needle oscillations, thereby permitting accurate current readings.

By a simple toggle switch, the stimulating electrode may be alternated from anode to cathode. The same switch has a neutral position in which the patient is removed from the circuit. By means of a pentode tube the variable resistance offered by different individuals is minimized. The pentode tube acting in the manner of a "mechanical governor" insures that the amount of current recorded on the milliameter dial is flowing through the patient when the patient is in the

circuit and that the same readings are maintained after the patient is removed from the circuit. This precludes the necessity of haste in obtaining readings and at the same time eliminates unnecessary discomfort to the patient.

It has been noted that patients who have been upset and intolerant of both therapy and testing when other apparatus was used are more relaxed when this new machine is used. Thus a more reliable test is obtained.

It has long been recognized that the current strength required to induce contraction of muscle varies with the length of time the current is applied. When the current is applied for long periods of time, the current strength required is less than when the current is applied for a shorter period of time. If the duration of the impulse is increased above 0.5 seconds, further change in the current strength usually is not required. Similarly, if the period of stimulus is progressively decreased, eventually no contraction is elicited regardless of how much current strength is used. It follows, therefore, that if one tested a muscle with stimuli which varied progressively in duration from 0.5 seconds to 0.001 seconds, recording the current strength necessary to induce a minimal visible contraction with each variation, a series of values which progressively increase would be obtained. If these values were plotted, a very definite curve would be formed. The term "strength duration curve" identifies this data.

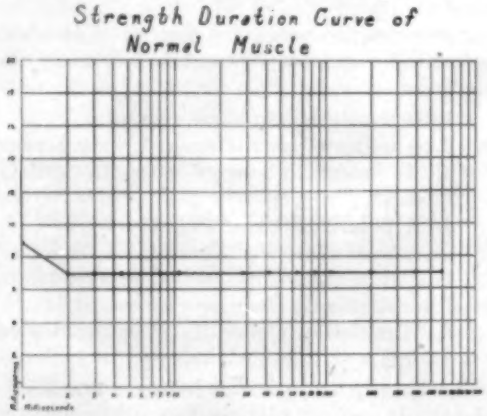


*Figure 2.*

The character of the curve varies remarkably depending upon the state of neurotization of the muscle. In the normal muscle the variation in current strength is relatively slight when the duration of the stimulus is altered; consequently, the curve is relatively flat and continuous. The curve in the denervated state is also a continuous smooth curve but has a very marked upward slope. The curve in the recovering or partially denervated state also has a sharp upward slope for the shorter stimuli but there are irregularities or so-called discontinuities in the curve. These discontinuities occur when the current strength required remains constant even though the duration of the stimulus is shortened (Figs. 2, 3, 4).

Chronaxie is an arbitrary term used by Lapicque[3] to describe that period of time required for a contraction when the current strength, double that of the rheobase, is used. Although this is an arbitrary figure, experience has shown that it is of value. In a normal muscle, the chronaxie is very short, 0.001 seconds or less. In the completely denervated state, the chronaxie is long, reaching figures as high as 0.300 seconds. Recovery cannot be predicted from this value alone until the chronaxie is less than 0.010 seconds. Chronaxie is one value of the strength duration curve and may be read directly from that curve. To determine this value, note the current value required for contraction at 0.500 seconds on the strength duration curve and then read the time required for contraction when the milliamperage is doubled. The strength duration curve is concerned with the effect of varying the duration of the stimulus. So-called repetitive stimulation is concerned with the effect on current strength for contraction when the interval between stimuli is varied.

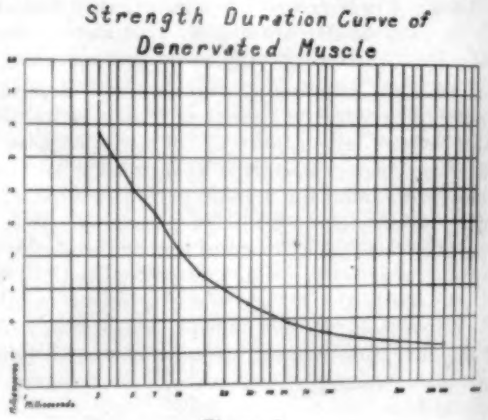


*Figure 3.*

It has been demonstrated that a series of rapid and regular stimuli of short duration may produce a sustained contraction or tetanus in a muscle. Alternating and faradic currents induce this phenomenon in a normal muscle but not in a denervated muscle.

One might use a series of various frequencies for stimulation; however, for this procedure frequency five hundred, frequency one hundred

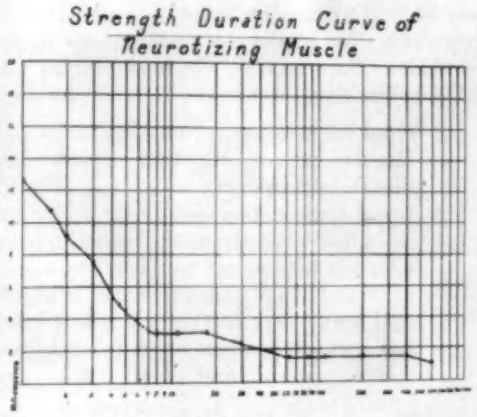


*Figure 4.*

sixty-six, and frequency seventy-seven have been arbitrarily chosen. A constant duration of impulse, 0.001 seconds, is used (Fig. 5).

In a normal muscle, within certain limits, the current strength required for tetanus is essentially the same, regardless of the change in interval between stimuli. In the denervated state, however, a much greater current strength is required for tetanus when the interval between stimuli is lengthened. When recovery begins, the current threshold for tetanus with low frequency stimulation becomes less and approaches identity seen in normal.

It had been reported that muscle contracts only on making and breaking of the galvanic current —and that the muscle did not contract during the flow of the current. Pollock[4] and his colleagues have called attention to the fact that either normal or denervated muscle may remain in sustained contraction or tetanus during the flow of the current.

While this phenomenon had been previously observed, its significance in clinical study escaped attention. It has now been demonstrated that the current required to induce tetanus in denervated muscle is much less than in normal or recovering muscle. Individuals conducting this study have introduced the term "galvanic tetanus ratio" which shows the *relation between the threshold current required for a minimal visible contraction, and that required for a sustained or tetanic contraction.* This ratio appears to be relatively uninfluenced by such local factors as edema, changes in the skin, temperature and atrophy.

The galvanic tetanus ratio is determined by dividing the strength of galvanic current in milliamperage required to produce a constant or tetanic response by the minimal strength of the same current required to produce a simple perceptible contraction.

The milliamperage required to produce tetanus in a normal muscle is from three to six times greater than that required to produce the minimal contraction. However, denervated muscle responds to minimal stimulation by a tetanus contraction. In other words, the same amount of current strength which causes a minimal contraction in the denervated muscle also causes tetanus.

The tetanus ratio changes with the state of innervation in this way: normal, 3 to 6; denervating, 6.0 to 1.0; denervated, 1.0 to 1.5; regenerating, 2.0 to 15.0 return to normal. This ratio will

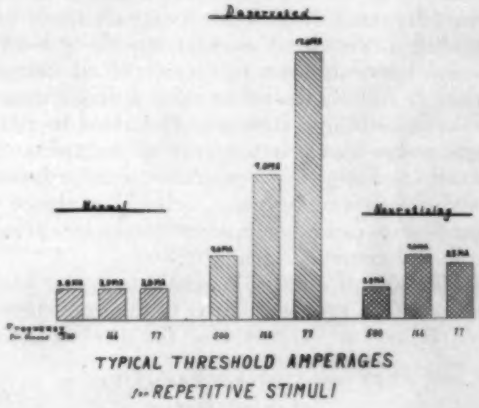


*Figure 5.*

apply to the evaluation of peripheral nerve lesions as follows: a ratio of 1.5 or below, observed one hundred days or more after injury with a lesion 25 centimeters above the motor point, indicates continued denervation and an unfavorable prognosis. Similarly one hundred days after suture, a ratio of 10.0 appears to be indicative of successful anastomosis, and that the nerve fibers have reached the muscle. The intervening time since injury is an important factor in determining the status of a nerve or muscle. The electrodiagnostic findings must always be considered in the light of the estimated rate of growth. *If sufficient time for reinnervation to occur has not elapsed since injury, a denervated picture may be noted even though regeneration is progressing satisfactorily.*

All patients with peripheral nerve injuries admitted to the neurosurgical section received electrodiagnostic examinations prior to operation. In certain instances when electrical examination indicated that muscle fibers were neurotized, operation exposed a lesion which was considered incapable of functional recovery. For a time this was confusing, but following an operation when resection and suture were performed,

the galvanic tetanus ratio fell to one, usually within thirty to forty days. This appeared to indicate that certain fibers which previously were reaching the muscle had been removed at operation. Pathological sections of the surgical specimens demonstrated that axis cylinders were present in the distal end. This confirmed the previous expectations concerning the galvanic tetanus ratio, but it also demonstrated the short-comings of this method of examination. There exists substantial evidence that the galvanic tetanus ratio is high or increased when the nerve fibers reaching the muscle are too few in numbers and too immature to accomplish a satisfactory restoration of function. In general, it appears likely that rambling nerve fibers may bridge the gap of a divided nerve and produce evidence of neurotization. It follows, therefore, that a single examination prior to operation usually cannot be relied upon unless there is evidence of complete denervation. Following operation when repeated examinations can be done, reliable evidence of regeneration can be determined weeks in advance of clinical recovery (Fig. 6).

All results of electrodiagnostic tests should be interpreted in proper relation to the time elapsed since injury or surgery and the site of lesion.

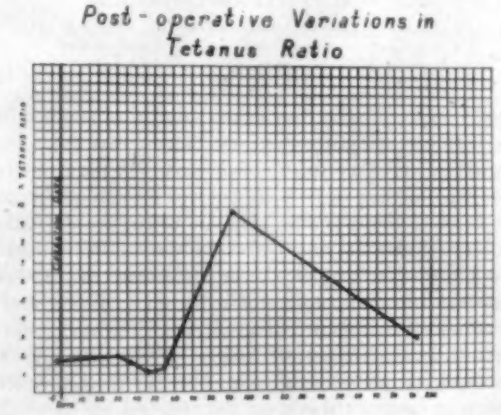


*Figure 6.*

For purposes of evaluation under ideal conditions, it has been estimated that nerve regeneration following complete Wallerian degeneration takes place at the rate of about five millimeters a day. This corresponds with the time when electrical signs of neurotization begin to appear. All results of electrical tests should be considered in relation to this anticipated maximum rate of regeneration.

Local factors such as changes of the skin, edema, and ischemia appear to have some influence on the entire electrodiagnostic picture. They should always be taken into consideration when evaluation of the electrodiagnostic findings are made. Other factors which should be taken into consideration are:

1. Dual innervation of muscles.
2. Higher neuron function, psychological blocks and hysteria.
3. Local muscle damage.
4. So-called "spontaneous neurotization" which is interpreted to mean that random or wandering neurons have bridged a real nerve gap, or that the severed nerve has sent out random fibers to an adjacent muscle without real nerve trunk formation.

Complete electrodiagnostic examination using the galvanic current includes the following values:

1. Galvanic tetanus ratio.
2. Strength-duration curve.
3. Chronaxie.
4. Response of repetitive stimuli of various frequencies.

Table I lists the various electrodiagnostic criteria and their usual variations.

The earliest electrical sign of regeneration usually appears as an increase in the tetanus ratio. This usually will be closely followed and at times preceded by the appearance of discontinuities in the strength duration curve. The decrease in the threshold range for minimal current stimulation with repetitive stimuli will generally follow the two signs previously mentioned. Chronaxie is probably the last of the criteria to approach normal during regeneration, although a decrease in chronaxie usually will be seen coincident with early repetitive stimuli changes.

As a general rule the evidence of neurotization occurs as described. Occasionally, however, one of the criteria may show evidence of denervation while others indicate regeneration. Interpretation in these situations is difficult and fortunately they are rare. They do occur, however, and it is considered advisable to carry out repeated examinations before an opinion is expressed.

## SUMMARY AND CONCLUSION

Routine physical therapy procedures for peripheral nerve injuries include hydrotherapy, some form of electrical stimulation and reeducational, mobilizing and strengthening exercises.

A new galvanic stimulator has been developed which incorporates many desirable features for use in electrical testing.

With the use of this machine, this new method

| | *Normal* | *Degenerating* | *Denervated* | *Regenerating* |
|---|---|---|---|---|
| Tetanus ratio | 3.0-6.0 | 10.0-1.0 | 1.0-1.5 | 2.0-20.0 |
| Chronaxie | Less than 1 | More than 15 | More than 15 | Less than 10 |
| Repetitive Stimuli | No threshold spread | Marked spread | Marked spread | Low to no spread |
| Strength Duration Curve | Continuous | Discontinuous sharp slope | Continuous sharp slope | Discontinuous sharp slope |
| Rheobase Ratio | 1.5-3.0 | 3.0-1.0 | 1.0 or less | 1.0 to 3.0 |
| Rheobase | | High to lower than normal | Very low below normal | High to normal |

of testing has been introduced in the Army's neurosurgical centers.

It was necessary to establish a certain fixed degree of contraction as standard. *The minimal visible contraction* has been recommended as that standard.

A new concept in clinical galvanic electrodiagnosis, namely, galvanic tetanus ratio, has proven valuable in preoperative and postoperative treatment of peripheral nerve injuries.

Galvanic tetanus ratio is obtained by dividing the current strength required for tetanus by the current strength required for a minimal visible contraction. Other values such as chronaxie, strength duration curve, and repetitive stimuli thresholds further complete the electrodiagnostic studies.

All results of electrodiagnosis must be interpreted in proper relation to the clinical picture as well as to the time elapsed since injury or surgery and the site of lesion.

By use of these electrodiagnostic values, the prognosis of nerve sutures may be determined well in advance of the sensory or motor return.

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# The American Physiotherapy Association:

## Personnel Policies for Qualified Physical Therapists*

The American Physiotherapy Association has received many requests from hospitals and other employers of physical therapists for advice concerning salaries and other personnel policies. The Association has felt for some time that it would be of mutual advantage both to the hospital and the physical therapist if stated personnel policies were established.

The physical therapist in common with other professional workers would like to know when accepting employment not only what will be expected of her professionally, but what she can reasonably look forward to in salary advance according to her capabilities and length of service and what opportunities there are for professional growth. Many physical therapists would prefer nonfederal employment but are attracted to the federal agencies because these facts are stated.

Under federal civil service the physical therapist is classified as professional and may be employed in classes P1-2-3-4-5. The initial salary in the P1 grade is $2644.00 and the maximum is $3397.20; P2—$3397.20 to $4149.60; P3—$4149.60 to $4902.00; P4—$4902.00 to $5905.20; P5—$5905.20 to $6862.80. These salaries are based on a forty hour week.

To obtain advance in rating, the physical

*A qualified physical therapist is one who has graduated from a school or course in physical therapy approved by the Council on Medical Education and Hospitals of the American Medical Association and/or is a member of the American Physiotherapy Association or a senior member of the American Registry of Physical Therapy Technicians.

therapist must present both personal and professional capabilities as well as additional educational qualifications, but the fact that there is an opportunity for advance in rank on the basis of merit presents a challenge and a goal.

We, therefore, recommend that comparable policies be established for physical therapists in nonfederal employment. It is realized that nonfederal institutions have not previously been able to meet the salary scales of federal civil service in all instances and that it may not be possible immediately to adjust to them.

In addition to salary and number of working hours, there are other factors to be considered in this specialized field.

*Case Load*

A job analysis or study of the work of the physical therapy department should be made to establish an average daily case load per therapist commensurate with good care of the patient. Some of the factors to be considered are: types of patients, children, adults, or both; types of cases, acute injuries, poliomyelitis, etc.; average length of a prescribed treatment; number of bedside treatments (time involved in going to and from the room, etc.). The study should also show whether the department is being conducted efficiently. Could more patients be treated if the schedule were planned more carefully? Would the employment of a maid, orderly, or clerk for routine duties permit the physical therapist to spend more time in administering prescribed treatment, teaching and supervising? Does the department coordinate its work with that of other departments?

The study should be conducted by the hospital superintendent, physician in charge of the department and supervising physical therapist. The decisions thus arrived at cooperatively have greater value than those set arbitrarily on the basis of compiled statistics.

*Vacations*

A minimum of two weeks vacation with pay with provision for increase in time according to length of service and responsibilities is recommended. Physical therapy is hard work and a generous vacation policy will prove to be good economics.

It might be pointed out that nonfederal institutions have an advantage over federal institutions in being able to offer a longer vacation period.

*Professional Conferences*

National professional conferences, such as the one held annually by the American Physiotherapy Association, are in effect refresher courses and do provide an opportunity for professional growth of the staff. It would seem advisable that at least one member of the staff attend a conference without loss of vacation time or salary. Some hospitals have arranged to send a supervisor or selected staff member to the conference with all expenses paid and others have given some financial assistance. Frequently these expenses are assumed by one of the voluntary groups, such as the women's board.

The physical therapist attending the conference would be expected to make a report to the medical staff and to share new knowledge with other members of the physical therapy staff.

*Hospital Insurance; Sick Leave; Social Security*

This is not a problem peculiar to physical therapists and it is generally recognized that there should be provision for adequate coverage of these items for all personnel.

The American Hospital Association has sponsored a hospital retirement plan and has strongly recommended that voluntary hospitals make it available to their employees. The retirement plan has been so prepared that should hospital employees later be included under Social Security, proper adjustment can be made.

A similar retirement plan is available for employees of Health and Welfare Agencies and is sponsored by Community Chests and Councils, Inc. The plans are underwritten by National Health and Welfare Retirement Association, Inc., 441 Lexington Ave., New York 17, N. Y., and reinsured by the John Hancock Mutual Life Insurance Co. of Boston, Mass.

*Conclusion*

The American Physiotherapy Association is cognizant of the responsibilities of hospitals "who must bear in mind not only quality of service and rights of employees, but also the burden thus placed upon those who must meet the cost of hospital care which is such a vital necessity in time of illness,"[1] that the physical therapist together with others "who serve the sick have opportunities for service and satisfaction beyond those available to any other of the employed groups"[2] also is recognized.

It is only after thoughtful study that the above recommendations are presented for consideration to hospitals and other employers of physical therapists.

1. Excerpt from a resolution of policy with respect to relationships between hospitals and employees, American Hospital Association.
2. Ibid.

# Schools Approved for Training Physical Therapists

*By Council on Medical Education and Hospitals of the American Medical Association*

| Name and Location of School | Medical Director | Technical Director | Entrance Requirements* | Length in Months | Classes Start | Tuition | Certificate, Degree, Diploma |
|---|---|---|---|---|---|---|---|
| Children's Hospital, Los Angeles[1] | Samuel S. Mathews | Lily H. Graham | a-b-c | 14 | Sept | $200 | Cert. or Degree |
| College of Medical Evangelists, Los Angeles[1] | F. B. Moor | A. H. Carlson | a-b-c | 12 | Sept | $225 | Cert. or Degree |
| University of Southern California, Los Angeles | O. L. Huddleston | Charlotte W. Anderson | a-b-d[2] | 12 | Sept | $496 | Cert. or Degree |
| University of California Hospital, San Francisco[1] | Frances Baker | Margery Wagner | a-b | 12 | Sept | $150 | Certificate |
| Stanford University, Stanford University, Calif.[1] | Wm. Northway | Lucille Daniels | a-b-d[2] | 12 | Jan June | $500 | Cert. or Degree |
| Northwestern University Medical School, Chicago | John S. Coulter | Gertrude Beard | a-b-d | 12 | Oct | $300 | Certificate |
| State University of Iowa Medical School, Iowa City | W. D. Paul | Olive C. Farr | b-c | 12 | Sept | $200 | Cert. or Degree |
| University of Kansas School of Medicine, Kansas City, Kans. | Gordon M. Martin | Ruth G. Monteith | a-b-c[2] | 12 | FebSept | $70[4] | Cert. or Degree |
| Bouve-Boston School of Physical Education, Boston | Arthur L. Watkins | Constance K. Greene | H.S. | 36 | Sept | $400 yr. | Degree |
| Boston University College of Physical Education for Women: Sargent College, Cambridge 38, Mass. | Louis Howard | Adelaide McGarrett | H.S. | 36 | Sept | $435 yr. | Cert. or Degree |
| University of Minnesota, Minneapolis[1] | Miland E. Knapp | Ruby M. Green | H.S. | 36 | Oct | $126[4] | Degree |
| Barnes Hospital, St. Louis | F. H. Ewerhardt | Beatrice F. Schulz | a-b-d | 12 | Oct | $200 | Certificate |
| St. Louis University School of Nursing, St. Louis[1] | Alexander J. Kotkis | Sr. Mary Imelda | H.S. | 36 | Sept | $300 | Degree |
| Albany Hospital, Albany, N. Y. | John W. Ghormley | Catherine Graham | a-b-c | 9 | Sept | $200 | Certificate |
| Columbia University, New York City | Wm. B. Snow | JosephineL.Rathbone | a-b-c | 1 or 2 yrs | Sept | $450 yr. | Cert. or Degree |
| New York University School of Education, New York City[1] | George G. Deaver | Elizabeth C. Addoms | a-b-d | 12 | Sept | $525 | Cert. or Degree |
| Duke University School of Medicine, Durham, N. C.[1] | Lenox Baker | Helen Kaiser | a-b-d | 12 | Oct | $300 | Certificate |
| D. T. Watson School of Physical Therapy, Leetsdale, Pa.[1] | Jessie Wright | Kathryn Kelley | a-b-d | 12 | Oct | $300 | Diploma |
| Graduate Hospital of the University of Pennsylvania, Philadelphia, Pa.[1] | George M. Piersol | Katherine S. Sutherland | a-b | 12 | Sept | $300 | Certificate |
| University of Texas School of Medicine, Galveston | G. W. N. Eggers | Ruby Decker | a-b-d | 12 | Jan | $141[4] | Certificate |
| Baruch Center of Physical Medicine of the Medical College of Virginia, Richmond, Va.[1] | Frances Hellebrandt | Josephine Buchanan | a-b-d[2] | 12 | Sept | $262[4] | Cert. or Degree |
| University of Wisconsin Medical School, Madison[1] | Elizabeth Grimm | Margaret Kohli | a-b-c[3] | 12 | Sept | $96[4] | Cert. or Degree |

*Courses are so arranged that any of the entrance requirements will qualify students for training. a = Graduation from accredited school of nursing; b = Graduation from accredited school of physical education; c = Two years of college with science courses; d = Three years of college with science courses; H.S. = High school graduation.

[1]Male students are admitted.

[2]High school graduates accepted for a four-year course leading to A.B. degree; students admitted quarterly and tuition is $166.65 per quarter.

[3]High school graduates accepted for four-year college course.

[4]Nonresidents charged additional fee.

# The Physiotherapy Review

*Editor-in-Chief:* LOUISE REINECKE

*Business Manager:* HELEN W. ECKERSLEY

*Associate Editors:*
GERTRUDE BEARD
MILDRED ELSON
HELEN MILLER

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Promotion of a real understanding of physical therapy in the allied professions is a matter of concern to all of us. One of the best means for accomplishing this is through chapter meetings.

There are several factors to be considered in planning to this end, but the most important one is that the program must be interesting and stimulating. The field for selection of material is virtually unlimited and may include such varied types of presentation as lectures, forums, case reports, motion pictures, clinical exhibits and study reports. If we earn the reputation for having good meetings there will be an increase in our own membership attendance as well as a desire in other groups for inclusion.

The place of meeting may be more important than is sometimes realized. It might be an advantage to meet at a hospital or medical school because of certain facilities, such as slide and motion picture projectors, clinic cases and physical therapy equipment. Also, it frequently is easier to draw attendance from diverse groups to such a place rather than to a restaurant or hotel. Meetings need not always be held at the same place if we have adequate publicity in the way of personal and newspaper notices.

We have heard of some very successful meetings at which physicians, occupational therapists and members of the hospital administration staff were present. Nurses, physical educators and members of social agencies are others who might be included at various times.

Those chapters located close to schools of physical therapy have a wonderful opportunity to build interest in the American Physiotherapy Association. The students are our future members and should be given an opportunity to see the best in our profession and organization. We must help them realize their responsibilities in the continuation of progress. We have always recognized the desirability of a more intelligent use of physical therapy. By inviting them to selected meetings, we may be able to give medical students and internes a wider view of physical therapy than they ordinarily receive in medical school.

This method of acquainting the related professions with the interests, problems and development of physical therapy presents a great possibility to each chapter and merits serious consideration in program planning. It is one which will repay us well in dividends of good will and appreciation.

## "History" Reprints Now Available

"The History of the American Physiotherapy Association" by Ida May Hazenhyer, M.A., which was published in four parts in the first four issues of The Physiotherapy Review for 1946 has now been reprinted in booklet form. The entire article has been bound together with a cover exactly like the present Review and makes an extremely valuable as well as attractive pamphlet. Copies are now available from the National Office of the American Physiotherapy Association, 1790 Broadway, New York 19, N. Y., at the cost of 50c. Order your copies now!

## Muscle Charts Available

A muscle chart has been prepared by the National Foundation for Infantile Paralysis under the direction of a medical committee on the treatment and after-effects of poliomyelitis. This chart is a standard type of record of muscle strengths especially desirable for use in the care of poliomyelitis patients and can be used advantageously by the physical therapy departments of hospitals and clinics. These charts are available free of charge and in quantity from the National Foundation for Infantile Paralysis, 120 Broadway, New York 5, N. Y.

The American Physiotherapy Association had an exhibit at the American Hospital Association conference entitled "Improvised Equipment." Members of the Pennsylvania Chapter, Inc., assisted the national office staff in setting up and manning the booth.

## Twenty-Fourth Annual Conference—1947

**Plan now for Asilomar. The conference program will be as stimulating to you professionally as we can possibly make it. The dates—July 6 to 12, 1947. The place—Asilomar, California, on the Monterey Peninsula.**

### Convention Tour—
### American Physiotherapy Association: Asilomar, California July 6-12, 1947

Special advantages: the good fellowship of friends; famous trains; Denver Mountain Parks; Pikes Peak; Garden of the Gods; The Royal Gorge; Mormon Tabernacle; confirmed reservations; a grand convention tour.

The convention at Asilomar and the convention tour offer you a real opportunity. Make your plans now and go.

Decisions should be made on routes very early in order to get confirmed reservations. The demand for accommodations last year was so great that many people were disappointed in both train and hotel reservations even when they had made up their minds three months in advance. Can you not make your decision by March 1 or even earlier. It will react to your *real* advantage. Why not begin asking questions now?

Rates are quoted as of October 1, 1946, and no changes are anticipated. Should there be any such changes, they will be reflected in the final statements or earlier. Routes and dates on the returns may be changed to meet individual desires. The tours offered are merely types. Any tour may be built to your order. Coach tickets may be "stepped" up for night journeys as desired, if and when sleeper space is available, and on payment of the additional cost.

The Pullman (standard) prices for the returns are quoted to New York only merely as a guide. Prices will be adjusted for other points, of course, on request. Economy prices apply to all points listed as the *round trip* rail fare is included in the convention tour price. Address all inquiries to:

Leon V. Arnold
36 Washington Square West
New York 11, N. Y.

Mr. Arnold will be very pleasantly remembered by a number of the members in connection with the postconvention tour of the Great Smokies last summer.

*The Coach (Economy) Price* includes round trip rail transportation throughout in air conditioned, individual reclining seat coaches with seats reserved where possible; Federal taxes; sightseeing with guides, taxes and tolls; hotel room with twin beds and bath as specified, two persons in a room. Single room if available, $5.75 additional.

*The Pullman (Standard) Price* includes Pullman Lower Berth westbound with all other items as named in the Economy Price.

**Convention Tour Rates**

| | *Coach* | *Pullman* | |
|---|---|---|---|
| Atlanta | $154.15 | $236.20 | The price of the |
| Boston | 181.00 | 287.50 | convention tour *in-* |
| Buffalo | 162.20 | 248.05 | *cludes your return* |
| Chicago | 142.00 | 208.15 | *transportation.* To |
| New York | 176.50 | 278.25 | these prices add the |
| Philadelphia | 173.10 | 270.95 | small cost of your |
| Pittsburgh | 161.10 | 244.70 | selected return trip. |
| Washington, D. C. | 171.25 | 265.15 | Write for complete return information. |

### About People You Know—

*Jean Beatty* is at Kennedy General Hospital, Memphis, Tenn.; also *Margaret Rhodes.*

*Hilda Case* has entered Western Reserve Medical School.

*Helen Kaiser* recently returned to Greece for a period of three months.

*Mary Lawrence* is studying for her Master's at the Medical College of Virginia.

*Captain Harriet Lee* is now in the Office of the Surgeon General, Washington, D. C.

### Pamphlet on Exercises for Amputees

The Surgeon General announces the publication of War Department Pamphlet No. 8-10, "Individual Exercises for Lower Extremity Amputees". The purpose of this pamphlet, which was prepared by the Physical Therapy Branch, is to provide the amputee with a definite guide which he may follow in carrying on his own exercise program. Illustrations accompany definite directions pertaining to the execution of each exercise.

This pamphlet supplements and is to be used in conjunction with War Department Technical Manual, TM 8-293, "Physical Therapy for Lower-Extremity Amputees," published in June 1946.

## Instruction Course at Hines

The Veterans Administration Hospital at Hines, Illinois, gave a course of instruction for physical therapists from October 1-14, 1946, under the direction of Dr. Louis B. Newman, physician-in-charge of medical rehabilitation at the hospital, and Florence S. Linduff, Field Supervisor in Physical Therapy, Central Office of Veterans Administration, Washington, D. C. The entire course of instruction was devoted to "Physical Therapy Procedures in Thoracic Surgery."

## National Society for Crippled Children

The National Society for Crippled Children and Adults, Inc., will hold its twenty-third annual meeting on December 9, 10 and 11, 1946, at the Palmer House, Chicago, Illinois.

## Doctor Rusk Will Head New Department

Dr. Howard A. Rusk, wartime Chief of the Army Air Forces Convalescent Services Program, has been named to head a new Department of Rehabilitation and Physical Medicine at the New York University College of Medicine.

The department will be the first of its kind in any medical college in the world and will train all students through their medical college years in what is termed the "third phase of medical care"—preparing the patient to go from the bed to the job. The department is an outgrowth and expansion of a division of physical medicine set up early last year as a part of the Department of Medicine under a grant of $250,000 from the Baruch Committee on Physical Medicine in 1944. Dr. George G. Deaver, clinical professor of physical medicine, is to continue as head of the physical medicine division of the new department.

A pioneer in military rehabilitation during the war, Doctor Rusk established the Army Air Forces' rehabilitation program in 1942. The later programs of the Army Service Forces and Navy, and now the United States Public Health Service and Veterans Administrations were patterned after this Air Forces' program.

Doctor Rusk will continue his positions as Associate Editor of the *New York Times* and as consultant in Medical Rehabilitation to the Medical Director of the Veterans Administration.

## Rehabilitation

The following letter was published in Dr. Howard A. Rusk's column on "Rehabilitation" in THE NEW YORK TIMES, Sunday, October 20, 1946, because he felt it represented the "totality of spiritual rehabilitation":

My name is John Crown. I am a paraplegia at Halloran General Hospital. My physical wounds are very small in comparison with my spiritual wounds. I have come back from death to a world that I no longer care for. I, who have been engaged in the great struggle to save the world from tyranny and having seen my comrades die for this cause, can now find no peace in the world or in my country.

Having lived close to death for two years, the reasons why there is no peace seem infinitesimally flimsy. Russia wants the Dardanelles, Yugoslavia wants Trieste, the Moslems want India, labor wants more wages, capital wants more profit, Smith wants to pass the car in front of him, Junior wants more spending money. To these, I say, is it necessary to kill and cripple human beings for these petty gains?

Anyone who thinks a human body is so cheap that it can be traded for a tract of land, a piece of silver, or a few minutes of time should be forced to listen to the moans of the dying night and day for the rest of his life.

All the troubles of the world originate in the common man. The selfish and greedy ways of nations are just the ways of each individual man multiplied a hundredfold. When the morals of the common man drop, so do the morals of the nation and of the world.

As long as our individual morals remain at a low ebb, so will be the world. Until each of us stops "hogging the road" with his car, stops fighting over the seat on the bus, stops arguing over who is going to cut the grass, there will be no peace in the world. If man wishes peace again, he must return to the great Commandment, "Love thy neighbor as thyself for the love of God."

Reprinted with permission from "The New York Times," October 20, 1946.

## Physical Therapy in Germany

The following is an extract from a letter from Captain Agnes P. Snyder, Coordinator of Physical Therapists in the Office of the Theater Chief Surgeon, United States Forces European Theater, Frankfort, Germany, describing observations made by her and 1st Lieutenant Constance Bennett, Medical Department Physical Therapist, at the Oscar Helenaheim Orthopedic Hospital in Berlin, Germany.

"It has been estimated that the German population suffered 300,000 major amputations as a result of World War II. Since the materials to supply this large number of prosthetic appliances are critical items, they will not be available for years to come. As a result of the need to rehabilitate these amputees as soon as possible, many ingenious devices and procedures have been developed.

"One of the most interesting procedures has been the development of the Krukenburg Arm. This procedure was surgically perfected during World War I by a German surgeon whose name

the arm now bears. For an individual who has lost a hand and wrist, an operation is performed to give him a pincer-like forearm with feeling surfaces. To be successful the forearm stump should have a minimum length of 18 cms.

"The operation carefully separates the bones of the forearm to about one-half the length of the stump. The forearm skin is closed over the end of the radius and the ulna is covered by a full thickness skin graft from an abdominal flap. As soon as the arm is freed from the abdomen and healed, physical therapy procedures are initiated. The patient is taught by the physical therapist to open the digits with the brachioradialis and the extensors of the wrist and to close them with the pronator teres and the flexors. For a good functional result, the patient should be able to open the digits at least 20 degrees and close them to the very end with some force.

"More than seven hundred Krukenburg operations have been performed at the Oscar Helenaheim Orthopedic Hospital in Berlin, six hundred of them since 1939. Four hundred operations have been on individuals with bilateral amputations of the hands, fifty of whom were blind.

"Before and after operation at the Oscar Helenaheim Hospital, the patient must take part in a vigorous program of general body exercises which includes calisthenics, sports and swimming. Postoperatively, the patient is given massage to the entire upper extremity and careful reeducation exercises by the physical therapist. At the same time the patient is active in the rehabilitation or work shop. Here he is taught to write, first making large movements using a large holder for the pencil. Later, as strength and coordination improve, he is able to write in a normal fashion, using an ordinary pencil. Each patient is supplied with a work book containing carefully prescribed lessons and charts for recording progress. The patient also is taught to use eating implements, beginning with large handles and gradually learning to use pieces of normal size. The shop aims to instruct each patient in an industrial trade which may be pursued in civilian life. The patient is hospitalized until he has learned to care for himself personally and to earn a livelihood.

"One patient demonstrated by the staff at the hospital was able to eat, write, button and unbutton his clothing, as well as perform many other routine functions. This patient had used his Krukenburg arm since 1939 and now spends his entire time in the hospital, rehabilitating other patients in its use.

"The Oscar Helenaheim Orthopedic Hospital maintains a school for the training of young German women as physical therapists. To qualify as students the young women must be physically fit, have a grammar school education, spend two years in training and pay a monthly tuition of 65 marks. The curriculum consists of anatomy, therapeutic exercise, massage, electrotherapy, hydrotherapy, physiology and pathology. The staff physicians act as instructors in many of the classes.

"The technical director of the school is Frau Anna Marie Hauptmann, whose background is that of a teacher of gymnastics, which was required by this school prior to 1939. Part of her hospital training was under the direction of Professor Doctor Klapp (Klapp's creeping exercise for scoliosis) in Berlin. Frau Hauptmann has been the technical director of this training school since 1939.

"It is interesting to note that the patients and the staff of the Oscar Helenaheim Orthopedic Hospital were moved to Czechoslovakia just before the capitulation of Germany in the spring of 1945. Frau Hauptmann and the sixty physical therapy trainees accompanied the patients in order that their training might not be interrupted. Within the year the entire group returned to Berlin to find a very much damaged hospital plant where they are now functioning under difficult conditions."

## Payment for Terminal Leave

The Surgeon General announces the passage of Public Law 500 (79th Congress) dated July 11, 1946, which authorizes the payment for accumulated and accrued annual civilian leave to female dietitians and physical therapists whose civilian appointments were terminated pursuant to section 4 of Public Law 828, dated December 22, 1942.

Unless such payment has already been accomplished, this legislation authorizes the payment for such leave for individuals in the following categories who served as civilian physical therapists in the Medical Department of the Army prior to March 31, 1943.

1. Commissioned physical therapists who are now in the military service.
2. Former commissioned physical therapists who have been separated from the military service.
3. Civilian physical therapists who were not appointed in the military service.

Information regarding the procedure for applying for such payment will be available in the near future.

## Medical Department Films Available To Medical Schools

Under a plan recently approved by the War Department, professional medical motion picture films produced for use by the Surgeon General are now available for loan to medical schools, medical societies, and individual physicians. Because of the legal restrictions imposed on most of these films, loans will be made only on approval of the Surgeon General's Office and only for non-profit showing to groups who are bound by the ethics of the medical profession. Borrowers are required to sign an agreement to abide by the conditions of loan.

A list of the films that may be of particular interest of physical therapists follows. All prints are 16 mm. Copies of the application form for loan of prints may be secured by writing the Surgeon General, Attention: Chief, Education and Training Service, The Pentagon, Washington 25, D. C.

TF 8-2070 *Reconditioning Convalescents for Return to Duty* B&W Sound 37 min. Presents the scope, significance, and operation of the reconditioning program in Army hospitals.

TF 8-2083 *Swinging Into Step* B&W Sound 33 min. Rehabilitation and morale film for amputees, showing graphically, how loss of limbs does not mean the patient cannot return to normal living.

MISC 956 *Meet McGonegal* B&W Sound 12 min. Picturization of a well known amputee, now a successful business executive, designed to show how well a man with two artificial arms can get along.

MISC 1081 *Reconditioning in the ETO* B&W Sound 29 min. Covers the phases of physical and occupational reconditioning as practiced in the ETO.

MISC 1129 *Diary of a Sergeant* B&W Sound 21 min. Designed for patients who have lost a limb. The purpose is to show them how one soldier in a serious situation was able to regain his place in normal happy living.

MISC 1173 *The Army Nurse* B&W Sound 15 min. The film explains the duties and activities of the Armp Nurse Corps.

MISC 1254 *Half a Chance* B&W Sound 11 min. Morale film for amputees showing how one amputee through the use of an artificial leg was able to participate in various sports including professional baseball.

MISC 1233 *Neurosurgery in an Overseas General Hospital* Color Sound 47 min. A record of typical neurosurgical problems encountered in overseas specialty centers. It is a film of primary interest to professional individuals, since it presents the various technical phases required for acceptable diagnosis, treatment and post-operative care.

MISC 1234 *Convalescent Care and Rehabilitation of Patients with Injury to Spinal Cord* Color Sound 41 min. Approved diagnostic, surgical, nursing, and physical medicine technic and practices pertinent to the care and rehabilitation of paraplegic patients are pictured.

MISC 1236 *Thoracic Surgery, Part I—Hemothorax with a Consideration of Specific Remedial Breathing Exercises* Color Sound 40 min. A presentation of the pathologic, diagnostic, and therapeutic aspects of hemothorax and other disorders of the pleura and the pleural cavity.

MISC 1249 *The Sky Is the Limit* Color Sound 20 min. A picture of the phases of rehabilitation that apply to an above-knee amputee. It portrays the proper walking technic for individuals with two normal lower extremities and for a unilateral AK amputee and it emphasizes many of the capabilities which are within the reach of the patient who possesses the will to strive for them.

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Auffant, Mrs. Gregoria, 32 Gonzales Ave., Rio Piedras, Puerto Rico.
Baldwin, Carol M., P. O. Box 487, Harwich Port, Mass.
Balshin, Lillian, 245 Main St., Hornell, N. Y.
Barker, Joyce, 15 Spring St., Carrollton, Ga.
Bartlett, Anna F., 1245 N. Genesee, Hollywood 46, Calif.
Bennett, Patricia A., 5305 Delmar Blvd., St. Louis, Mo.
Berg, Mrs. Myrtle M., 612 S. Center St., Beaver Dam, Wis.
Bingham, Edythe F., 595 E. 167th St., Apt. 5F, New York 56, N. Y.
Booman, Mrs. Ruth S., 1380 Birmingham St., St. Paul, Minn.
Bouden, Evelyn S., 331 N. 40th St., Philadelphia 4, Pa.
Bunce, Miriam, Route 2, Mancos, Colo.
Bunger, Margaret C., U. S. Naval Hosp., Chelsea, Mass.
Burmeister, Elizabeth F., 1621 Northland Ave., Lakewood, O.
Burt, Lt. Louise B., overseas.
Calloway, Helen C., 217 W. 14th St., Sioux City, Iowa.
Carr, Bernice K., 325—41st St., Fairfield, Ala.
Case, Florence E., 902 Grant St., Madison, Wis.
Cason, Jeanne, 2410 Pacific Ave., San Francisco 15, Calif.
Chapman, Adelaide, 287 Franklin St., Quincy, Mass.
Cleary, Ella Veronica, 546 Bay Ridge Ave., Brooklyn, N. Y.
Connolly, Madeleine M., 1221 Overington St., Philadelphia, Pa.
Cookerly, 283 E. Main St., Frostburg, Md.
Curtis, Mrs. Olga H., 247 N. Centre Ave., Rockville Centre, N. Y.
Davis, Lt. Alice M., Station Hospital, Camp Polk, La.
Davis, Dorothy M., 616 W. 116th St., New York 27, N. Y.

Denton, Lt. Elizabeth, P. T. Dept., Station Hosp., Fort Knox, Ky.
DePinto, Angela, 1748 E. 177th St., Bronx, N. Y.
Dickinson, Ruth, 440 N. Arlington Ave., E. Orange, N. J.
Dierickx, Blanche M., 1136 Gaylord, Denver, Colo.
Dolph, Margaret J., 26 Stillmann Ave., Cornwall-on-Hudson, N. Y.
Dorrance, Virginia, 54 Euclid Ave., Maplewood, N. J.
Doten, Mrs. Louise T., 308 Webster St., Needham Heights, Mass.
Drake, Mary, 79 Upland Road, Cambridge, Mass.
Dryden, Patience, 618 N. Bradley, Indianapolis, Ind.
Eagan, Jane, 1932 E. 105th St., Cleveland, O.
Edelen, Audrey M., 1119 Vine St., Denver, Colo.
Eiden, Marian A., 3001 N. New Jersey, Indianapolis, Ind.
Evanson, Dolores L., Lemmon, S. D.
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Frey, Raymond T., 43 High St., Lebanon, Pa.
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Grant, Barbara, 1 Greenview Way, Upper Montclair, N. J.
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Haase, Ruth Phyllis, 160 Strathmore Rd., Brighton, Mass.
Hallfrisch, Lt. Frances C., Army-Navy Gen. Hosp., Hot Springs, Ark.
Hank, Lt. Mildred G., overseas.
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Kennedy, M. Elizabeth, 219 E. Church St., Frederick, Md.
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Lange, Wilma, Freeport Hotel, Freeport, Ill.
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Macdonald, Claire M., 29 University Rd., Brookline, Mass.
Maiorello, 131 E. North St., Bethlehem, Pa.
Matthews, Mrs. Jean, 1568 Pacific Ave., Long Beach 6, Calif.
McDonnell, Mary E., 507 Cumberland Apts., Louisville, Ky.
McElroy, Ann, 647 W. 8th St., Erie, Pa.
McNabb, LaVerne, 610 Orient Drive, Kansas City, Kans.
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Musa, Karol, 42 Oakdale Blvd., Framingdale, L. I., N. Y.
Musick, Martha A., 5510 Harrison St., Kansas City 4, Mo.
Nash, Frances, 128 E. Mazon Ave., Dwight, Ill.
O'Brien, Mary E., 31 Linden St., Schenectady, N. Y.
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Pattison, Rose I., Birmingham Gen. Hosp., Van Nuys, Calif.
Phillips, Mrs. Dorothy M., 2216 Leer St., South Bend, Ind.
Richers, Elizabeth, 332 N. Lansdowne Ave., Lansdowne, Pa.
Rivera, Carmen M., 512 W. 162nd St., Apt. 8, New York 32, N. Y.
Rosenzweig, Mildred, Reconstruction Home, 318 S. Albany St., Ithaca, N. Y.
Ross, Anna V., Box 91, Newport, Del.
Roush, Frances K., 141 S. Meridian St., Indianapolis, Ind.
Royson, Harry, 418 Central Park West, Apt. 50, New York, N. Y.
Ryan, Lucy C., Broadview Hotel, East St. Louis, Ill.
Ryer, Mrs. Katherine, 11½ E. First St., Fort Scott, Kans.
Schatz, Marion I., 1828 Pine St., Philadelphia 3, Pa.
Steiner, Ruth Rita, 357 Craig St., Erie, Pa.
Stinson, Jeanne E., 608 S. Marks St., Fort William, Ontario, Canada.
Strelnick, Daniel H., 20-59 29th St., Astoria 5, L. I., N. Y.
Swartz, Mrs. Nell H., P. T. Dept., Univ. of Tex., Medical Branch, Galveston, Tex.
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Taylor, Cora Alice, 3205 Ave. 0½, Galveston, Tex.
Tracy, Phyllis M., Box 417, Sayville, L. I., N. Y.
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Kinzer, Elizabeth E.
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Marcum, Sara Elizabeth
Mauldin, Norma E.
Moeller, Ruth I.
Rusch, Clara M.
Snyder, Clara Mae
Thomas, Mavis Maxine
White, Evelyn D.
Young, Kate

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# ABSTRACTS

**John S. Coulter, M.D.**

### Infantile Paralysis, or Acute Poliomyelitis: A Brief Primer of the Disease and Its Treatment

The American Orthopedic Association. Special Article in JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 131:17:1411, August 24, 1946.

Poliomyelitis, or infantile paralysis, is an acute generalized systemic disease caused by a virus and characterized by inflammation of various parts of the central nervous system but particularly by the damage to or destruction of the large motor cells in the spinal cord, with resultant paralysis of the voluntary muscles innervated by them.

Many statistics are available from many parts of the world since the time of Wickman, 1911, to the present day. A survey of these leads to the following observations:

1. The abortive, or nonparalytic, type constitutes at least 20 per cent of the total cases reported. This percentage has been much higher in instances in which more careful diagnostic search has been made for these cases. As paralysis has never been present, they should be excluded from statistics of complete or partial recovery from definite paralysis.

2. Spontaneous complete recovery from paralysis has occurred in from 35 to 60 per cent. Many statistics do not enumerate the number of abortive cases and must be excluded from consideration. When all cases, including the abortive cases, are considered, complete recovery has occurred in from 55 to 80 per cent.

3. About 2 per cent remain completely disabled.

4. Ten to 20 per cent require the use of braces or aid from reconstructive surgery.

5. The remainder have no significant handicap.

On the whole, the prognosis in poliomyelitis is favorable, and one may agree with one author who states that "with good care 75 to 85 per cent of the cases will show marked improvement or complete recovery."

*Treatment in the Recovery Stage*

*A. Subacute Recovery Stage*—As early as possible in this stage it is desirable to get a muscle check so that one can have a basic estimate of the extent of the disease and the degree of damage done to start with. A week or more may be required in a bad case before a full muscle chart can be completed.

As the anxiety and irritability of the patient subside with the regression of virus activity, the sedation can be slowly reduced. The actual pain varies greatly in cases, from complete absence of discomfort to exquisite hyperesthesia.

Exercise may be begun tentatively as pain subsides and increased only as tolerated readily by the patient without evidence of fatigue. Massage is not used at this stage because of sensitivity of the muscle masses, but passive movement of joints in paralyzed extremities may be started over a comfortable arc of motion. Motion begun early and gently performed can prevent stiffening of joints, and it is especially beneficial where splinting is used to insure against restrictive contracture.

*B. Convalescent Stage*—This is reached in a couple of days. This is the period when physical therapy reaches its maximum usefulness, for massage and educative exercises are of the utmost importance in restoring weakened muscles to their utmost effectiveness.

It is at this time that care in an orthopedic children's hospital is most beneficial. Hospitalization is also extremely valuable in the general reeducation of the patient who is taken out of the individual sickroom where fear and self pity bloom so quickly and placed in a company of his peers, all of whom are making the same struggle to recover and adjust.

The physicians, nurses, physical therapists, occupational therapists and teachers all have their active part to play in this great process of psychologic readjustment and team play to give the institution its essential esprit de corps and healthy atmosphere of cure.

General rest becomes less important gradually, but local protection of the affected parts is still in order. There should be careful muscle checks at the start and at monthly intervals of all paralyzed or weakened muscles, both to guide treatment and to foster the patient's interest and morale. Underwater exercise in tubs or pools is useful at this stage and serves to give the patient confidence as well as exercise.

Braces are often required as temporary aids to recovering weakened muscles and, in the lower extremities, are used as substitute supports. Not only must the weakened paralytic muscles have careful attention, but the strong and often unopposed normal muscles must be supervised to prevent contractures and distortions occasioned by their imbalanced strength. Atrophy of paralyzed muscles is present early and, as a result of the lessened circulation so produced there may be changes in the growth rate of bone in a paralytic extremity.

### Rapid Rehabilitation Following Hand Injuries

Harold Lefkoe, M.A., M.D., D.N.B., A.L.C.S., Orthopedic Surgeon, St. Luke's and Children's Medical Center; St. Joseph's Hospital; Jewish Hospital, Philadelphia; Consultant Orthopedic Surgeon, Coatesville Hospital, Philadelphia. In ARCHIVES OF PHYSICAL MEDICINE, 27:8:499, August 1946.

*Summary*

The importance of rapid rehabilitation of hand injuries has been emphasized again.

An attempt is made to disseminate many of the already known physical medicine technics, so that their use will become more widespread.

Attention is called to new technics which should be accepted into the therapeutic armamentarium of the specialist in physical medicine and which should be used in conjunction with the older, well tried methods to accomplish a more rapid rehabilitation of the injured hand.

### Effects of Denervation on Fasciculations in Human Muscle—Relation of Fibrillations to Fasciculations

Francis M. Forster, M.D., Winslow J. Borkowski, M.D. and Bernard J. Alpers, M.D., Philadelphia. In ARCHIVES OF NEUROLOGY AND PSYCHIATRY, 56:3:276, September 1946.

In a previous communication evidence was presented to the effect that fasciculations in voluntary muscle have their site of origin not in the anterior horn cell but at the myoneural junction. This evidence consisted of the demonstration of continued fasciculations during pharmacologic block of the appropriate peripheral nerves or nerve roots and of the alteration of the frequency of fasciculations by drugs acting at the myoneural junction.

Subsequently, Denny-Brown mentioned the disadvantages of pharmacologic block and indicated that this type of block could not be considered absolute in the physiologic sense, for the drug employed need not affect all the fibers in a given nerve to the same degree nor could the interference with transmission of sensory or voluntary motor stimuli permit one to conclude that all impulses were blocked.

For these reasons, confirmatory evidence for our previous premise regarding the site of origin of fasciculations was sought. It was thought that this could be supplied by observations on muscles denervated by section of the motor nerve supply. It was also hoped that by these studies some light might be thrown on the confusing problem of the relationship, between fasciculations and fibrillations.

*Summary*

Fasciculations do not arise at the anterior horn cell, since they are present for a time after denervation of the fasciculating muscle. Fasciculations, like fibrillations, originate at the myoneural junction. Fasciculations and fibrillations probably represent the same phenomenon, the only difference being that fasciculations are synchronized fibrillations occurring in the same motor unit. The decrease of fasciculations about four days after denervation correlates with the anatomic changes in the peripheral nerve stump. Fibrillations are probably synchronized into fasciculations by antidromic impulses from the myoneural junction and firing in axon reflex fashion. The disappearance of fasciculations is due to the destruction of the synchronizing pathway when the peripheral stump degenerates.

### Responses of Single Human Motor Units to Electrical Stimulation

E. Kugelberg and C. R. Skoglund. The Nobel Institute for Neurophysiology and the Neurological Clinic, Karolinska Institutet, Stockholm, Sweden. In JOURNAL OF NEUROPHYSIOLOGY, 9:5:391, September 1946.

Clinical electromyography has usually been limited to studies of voluntary contractions or of spontaneous activity in the muscle but a systematic analysis of muscular function using electrical stimulation of the nerve, such as is common in animal experiments has been less used in clinical investigations. In previously published experiments of this kind synchronized potentials from many simultaneously active units resulting from maximal or submaximal test shocks of short duration have been recorded. These mass effects are difficult to interpret even under physiological conditions and are therefore far from ideal for the analysis of pathological phenomena. It is, therefore, desirable to find a method which would enable one to study the responses of individual human motor units to electrical stimulation.

This paper describes a modification for human material of Skoglund's method for recording the activity of individual motor units to electrical stimulation with currents of different gradients. Although the object of the method was originally clinical, the application has for the present been limited to the study of some physiological problems which emerged from Kugelberg's study of accommodation in human nerves. Therefore a determination was made of the accommodation of a single motor unit and it is a matter of interest to compare these results with earlier data from experiments in which the muscle twitch was used as an index. The technic has also been used to detect differences in excitability between the proximal and distal parts of the same nerve fiber.

*Summary*

1. The responses of single human motor units to stimulation with instantaneously or slowly rising currents are demonstrated.

2. Accommodation curves with the electrical response of a single motor unit as index were determined and are compared to those given by a muscle twitch.

3. The duration of the motor unit responses to constant currents of various strength—the so-called adaptation time—was determined. Significant differences were found to exist for the proximal and distal parts of the same fiber, the former showing a longer adaptation time.

### The Relationship Between Total Heat Exchange and Blood Flow in the Hand at Various Ambient Temperatures

R. E. Forster, II, B. G. Ferris, Jr., and R. Day, U. S. Army, Quartermaster Corps, Climatic Research Laboratory, Lawrence, Massachusetts. In AMERICAN JOURNAL OF PHYSIOLOGY, 146:4:600, July 1946.

In the past, the temperature of the arterial blood entering the hands and feet has been assumed to be close to the deep body temperature under normal conditions. This assumption has constituted the basis for investigations of blood flow employing the calorimetric technic of Stewart. The possibility of arterial blood being cooled prior to its entry into the extremity, either by cooler tissues about the vessel or by returning cool venous blood in the neighboring vein has, however, been suggested. These present studies demonstrate this phenomenon in the hand at various ambient temperatures.

*Summary*

1. An air filled combination plethysmograph and calorimeter has been constructed which measures the blood flow in the hand, and the heat loss by radiation, convection and evaporation. Measurements have been made of blood flow and of heat loss with the entire body exposed to ambient temperatures of from 15 to 38 C.

2. Hand blood flow rates as low as 0.15 cc. per hundred cubic centimeters of hand tissue were recorded after exposure of the body to the cold for several hours.

3. The temperature drop in the blood as it passes through the hand can be calculated from the figures obtained. It is submitted that there must be considerable cooling of arterial blood before it enters the hand.

### Course and Rate of Regeneration of Motor Fibers Following Lesions of the Radial Nerve

Sydney Sunderland, M.D., D.Sc., Melbourne, Australia. In ARCHIVES OF NEUROLOGY AND PSYCHIATRY, 56:2:-133, August 1946.

The object of this paper is to record and to discuss the significance of observations on the course and rate of regeneration of motor fibers following complete interruption of conduction in the radial nerve due to gunshot wounds, simple fractures of the humerus, penetrating injuries and lacerations. The results of an investigation of simple compression injuries of this nerve have already been described (Sunderland).

Detailed observations on motor recovery have been reported by Stopford and by Seddon, Medawar and Smith. Reference will be made to the results of their studies in the appropriate sections of the text.

In the present investigation of a series of 63 lesions of the radial nerve particular attention was paid to the following points:

1. End results.
2. Course of spontaneous regeneration and the regeneration following suture.
3. Pathologic features of the lesion, as deduced from a study of the course of regeneration.
4. Selection of cases suitable for investigation of the rate of regeneration of peripheral nerves in man.
5. Rate of regeneration, which was estimated over different segments of the nerve in order to determine whether regeneration progresses at a uniform rate or otherwise.

*Summary*

Observations on the course and rate of regeneration of motor fibers following lesions of the radial nerve are described.

The end results in a series of 63 cases of such lesions, on which the observations are based, are briefly summarized.

Reference is made to the significance of variations in the serial order of motor recovery.

The pathologic character of the lesions is analyzed in terms of the course of regeneration.

A method for estimating rates of regeneration of functionally mature motor fibers in human peripheral nerves is described. With this method, rates of regeneration have been calculated over proximal and distal segments of the nerve below the origin of the branch to the brachioradialis. The results indicate that there is a progressive diminution in rate as regeneration advances.

In cases of axonotmesis mean rates of 1.9 and 0.8 mm. per day were obtained for the proximal and distal segments of the nerve, respectively. In cases of suture, mean rates of 1.2 and 0.6 mm. per day were obtained for the proximal and distal segments of the nerve, respectively.

Observations were made on the period intervening between the injury and the time when regenerating axons enter the distal segment—the initial delay—in cases of axonotmesis and suture.

(a) The duration of the initial delay is a measure of the degree of severity of the injury.

(b) The relationship of the duration of the initial delay to the reinnervation of the motor field subsequent to the onset of recovery is discussed in some detail. In general, initial delays of long duration are associated with longer periods for the reinnervation of the motor field. An early or a late onset of recovery is not, however, invariably followed by a subsequent accelerated or retarded rate of recovery.

(c) An initial delay of up to 10 weeks may be expected in cases of injuries which are minimal in degree and which are usually due to uncomplicated trauma. If the lesion is more severe, as it is after suture or after severe gunshot wounds associated with a fracture of the humerus, infection and intensive scarring, then a delay of approximately 4 months may be expected. It is, however, difficult to distinguish between simple and severe nerve lesions, since the nature and severity of the causative injury are by no means an invariable guide.

From a knowledge of the presumed initial delay, the level of the lesion and the rate of regeneration, it is possible to ascertain when recovery, spontaneous or following suture, should be expected.

By adding 11 to 23 weeks, according to the type and severity of the nerve lesion, to the date of onset of recovery in the first muscle to be reinnervated, it is possible to calculate the approximate time when voluntary contraction may be expected in the last muscle to be reinnervated.

The maximal period intervening between the injury and the onset of recovery—latent period—before spontaneous regeneration became evident and proceeded to completion was 10 months. In the majority of nerves regenerating spontaneously, however, recovery had appeared at the end of 6 months.

### Treatment of Tuberculosis of the Larynx: An Evaluation

William F. Hulse, M.D., Cleveland. In ARCHIVES OF OTOLARYNGOLOGY, 43:6:578, June 1946.

Ultraviolet ray therapy has long enjoyed extensive popularity in the general field of tuberculosis. In an earlier day it was considered as absolutely essential, regardless of the type of disease which was present. Before present day concepts of tuberculosis therapy were established, sunlight and a nutritious diet shared the only therapeutic halo available. Modern therapeutic measures have somewhat dimmed the luster of these two factors. Actually, certain types of pulmonary tuberculosis are probably rendered worse by irradiation. The use of ultraviolet rays is contraindicated in the acute exudative type of pulmonary or laryngeal tuberculosis. The use of ultraviolet rays, either natural or artificial, has until recently been widely accepted as a somewhat exalted therapeutic measure in laryngeal tuberculosis, and the various contrivances which were used to pipe the rays to the seat of the trouble were ingenious, though there probably was little benefit derived therefrom. It is doubtful whether under the very best of conditions more than a small fraction of the rays ever survived the trip through the various contours of the hypopharynx. Since ultraviolet rays are capable of penetrating only to a depth of a few millimeters, those which did reach their destination left the actual seat of trouble largely undisturbed. Generalized exposure to ultraviolet rays has come to be accepted by many as being most beneficial in extrapulmonary tuberculosis, and I assume that laryngeal tuberculosis probably received some tangible aid from its use. It should be regarded solely as a supportive measure and nothing more.

Far out in front in the modern methods of attack on laryngeal tuberculosis is electrocautery. After this method was developed and recognized it superseded all others for a decade or more. At the zenith of its popularity it was considered to be appropriate for all forms of laryngeal tuberculosis until more modern concepts of pulmonary therapy were developed. It has been recognized for some time that most infections in the body will do much better after an operative procedure if it is feasible to permit

the body to wall off the infection to the greatest extent which good judgment will allow. If the body is not able to produce such a response, then cautery will be of no avail. If cautery is instituted before this has taken place, its employment may be expected to be disappointing not only from the standpoint of eradication of the disease but also from that of physiologic function. A considerable number of patients are to be seen today whose general physical condition is functionally far superior to their laryngeal status, and this I believe to be the result in the vast majority of instances of inopportune or overenthusiastic cauterization or both.

Electrocautery may be said to have two main functions. The first is the destruction of diseased tissues and the second a local stimulation of tissues due to the resultant hyperemia. Just what part each plays in a given case cannot be determined with any degree of accuracy.

### Studies of Neuromuscular Dysfunction: VIII: Use of Curare to Differentiate Muscle Spasm from Organic Changes in Limitation of Passive Motion at Joints

Charles Wilson Jones, M.D., Washington, D. C., Calvin B. LeCompte, M.D., Anesthetist, Freedman's Hospital, Washington, and Herman Kabat, M.D., Ph.D., Washington, D. C. In SOUTHERN MEDICAL JOURNAL, 39:10:799, October 1946.

*Summary and Conclusions*

(1) Seventeen cases are presented in which curare was used as a test of muscle spasm in joints showing limitation of passive motion. This test is capable of differentating muscle spasm from organic factors in limitation of passive joint motion. Eight of the seventeen cases in this series showed the presence of muscle spasm, as evidenced by increases in range of motion as a result of muscular relaxation.

(2) This test should be of major practical importance in helping to establish the correct approach to therapy.

(3) Five of seven fracture cases which showed increase in range of motion from curare retained the improvement in full or in part, which suggests the possibility of using curare as an adjunct to treatment of such cases.

(4) Curare can relieve joint pain by relaxation of muscle spasm.

### Physical Therapy in a General Practice

G. J. P. Barger, M.D., Director of Physical Therapy, Georgetown University Hospital and Medical School, Washington, D. C. In SOUTHERN MEDICAL JOURNAL, 39:9:737, September 1946.

There are certain disabilities of the neck, the shoulder girdle, the hip girdle, of the back, of the knees and of the feet which are amenable to manipulation. It is important to have a history of the case, a physical examination and x-ray studies in many cases, to determine whether manipulative treatment is indicated and safe.

Neck disabilities amenable to manipulative technic are usually of sudden onset, show stiff, sore muscles or wry neck. Neck stretching, with the Sayre head sling or by hand is the usual procedure. Repeat several times at a session.

A condition seen very commonly, a severe occipital headache with scalp neuralgia, often responds in a few minutes to digital pressure usually under the mastoid processes, at times over the first spine.

Shoulder disabilities amenable to manipulative technic are usually of sudden onset, with pains between shoulder blades and radiating down arm. At times this is difficult to differentiate from bursitis or myositis. Often the source of this pain is at a joint between rib head and vertebrae. Manipulation seeks to open this joint slightly or rock it, by use of leverage. Relief often is dramatic in early cases.

Thoracic region disabilities amenable to manipulative technic are often of the rib head lesion type at fourth to tenth nerve roots one side. Symptoms are referred pains around ribs, over chest or heart or abdomen. They often arouse fears of heart or lung disease or appendicitis. Gentle manipulation seeks to stretch or rock joint at rib head, which can sometimes be done by crawling on all fours, or hanging and stretching.

Lumbar region disabilities are not often amenable to manipulative technic in my experience. I depend more on heat and electric massage in these cases. Bony anatomical deviations are often found here.

Sacro-iliac joint disabilities often are dramatically amenable to manipulation designed to stretch or rock the joint.

Knee injuries probably of the order of loosened or slightly displaced semilunar cartilages can sometimes be aided by manipulation, by circumduction of leg with knee bent at right angles.

Most manipulations must be learned by observation and practice. The longer the interval between the onset of pain and the manipulative procedure, the more likely there are to be productive changes, due to irritation and disturbed circulation, and the more difficult to correct by manipulation.

### Painless Treatment of Ankylosed Joints: A Report of Nineteen Years' Study

Joseph Echtman, M.D., New York, N. Y. In MEDICAL RECORD, 159:8:477, August 1946.

I have endeavored for many years to work out definite but painless methods of treating disease. This has been achieved in a few clinical conditions, and the results of some of this work have appeared in medical journals. This paper shall report the results of another line of work by means of which I hope to benefit the injured of the U. S. armed forces (as well as civilians) who suffer from ankylosed joints.

This report will deal exclusively with the treatment of fibrous ankylosis. Bony ankylosis is not amenable to physical medicine. It is the task of the surgeon alone.

*Author's Method*

The method, or system of methods, described in this paper is of definite therapeutic value, and at the same time painless and safe. I shall call it the combined ion transfer and interrupted sine wave method. It consists of two separate procedures, ionization followed by interrupted sinusoidalization.

The prerequisites are apparatus, drugs, towels, metal, bandages, glass or porcelain vessels and hot water. One apparatus delivering both currents, galvanic and sinusoidal, e.g., the Morse wave, etc., is used. Separate apparatus may be used.

*Summary*

A system of methods for the safe and painless treatment to restore joints crippled by fibrous ankylosis, offering definite results, is presented. It is my original work based on experience with thousands of patients during a span of nineteen years in five hospital clinics.

### Physiotherapy in Rheumatic Diseases: The Choice of Suitable Methods at Various Stages

L. Schmidt, M.D. (Prague), Consulting Physician and Medical Supervisor to the Rheumatism Clinics of the Butterley Collieries and Ironworks. In BRITISH JOURNAL OF PHYSICAL MEDICINE AND INDUSTRIAL HYGIENE, 9:4:104, July-August 1946.

*Treatment of Sciatica*—In the prescription of physical therapy it is well to concentrate first on the treatment of the spastic muscles with histamine ionization. This has to be done, as a rule, in three stages. The dispersive (in this case negative) electrode is best placed over the popliteal fossa and the active (positive) electrode first on the lumbosacral muscles, then on the gluteal muscles and finally on the peroneal region; when there is a distinct numbness of the feet and toes, a fourth stage should be added by placing the active electrode on the upper part of the foot.

As soon as the most acute pains have gone, histamine ionization should be replaced by iodine ionization, given in the same manner. It is of distinct importance with sciatica to use tincture of iodine—not sodium or potassium iodide—the ionization being applied directly to the skin; this produces far better results. Whether or not this is due to the fact that tincture of iodine acts also as a skin irritant, it is hard to say. On the other hand, it is a fact that certain "quick cures" of sciatica, performed mostly by quacks and surrounded with great secrecy, are carried out by means of some powerful skin irritant which causes actual blistering. Needless to say, such forms of treatment are most dangerous, as they may easily lead to nephritis, which may make the patient ill for the rest of his life and often even bring about an early death. No curative agent should ever be used with such ultra-intensity as to cause serious harm to the trusting patient.

Heat, even in mild form, is badly tolerated—this is certainly so in the beginning—and it usually does not improve matters. In any case one has to be very careful with its application, as a certain anesthesia of the skin is often present; thus burns may be produced easily.

Massage should be applied in the final stage only, in order to try to free the nerve from the adhesions between it and the nerve sheath which are, in most cases, an inevitable consequence of the acute inflammation. These adhesions are to blame for the numbness which often prevails for a long time after the disease as a whole is considered to be more or less cured.

### Rehabilitation of the Tuberculous in Industry

Norvin C. Kiefer, M.D., and Herman E. Hilleboe, M.D., Surgeon and Medical Director, respectively, U. S. Public Health Service, Washington, D. C. In JOURNAL OF AMERICAN MEDICAL ASSOCIATION, 132:3:121, September 21, 1946.

Rehabilitation and aftercare must be preceded by adequate diagnostic facilities and proper medical treatment. Unfortunately however there is as yet insufficient realization of the fact that, without rehabilitation and aftercare, much or all of the time, effort and money spent on diagnosis and treatment will be wasted.

Rehabilitation in tuberculosis is the restoration of tuberculous persons to the fullest physical, mental, social, vocational and economic usefulness of which they are capable. Vocational rehabilitation, which is only one phase of the complete process of rehabilitation, was defined as meaning any services necessary to render a tuberculous person fit to engage in an occupation suitable to health and aptitude.

A number of studies indicate that the tuberculous expatient is a satisfactory employee. Any increased absenteeism attributable to illness and the necessity for special attention to even minor complaints is equalized by a decrease in absenteeism that results from nonmedical causes. A rather common experience of employers is that the tuberculous expatient is more loyal than the average well employee. Whether this is a consequence of gratitude for having received employment, of fear of losing a job or other factors is irrelevant.

It does not seem unfair, therefore, to believe that an employer is obligated to reinstate any former employee who has recovered sufficiently from tuberculosis. This statement remains true even when, at first, the expatient and exemployee is able to start at only four hours' work per day and may have to be placed at work which is more suitable to his physical limitations. Even these disadvantages may be more than compensated by the broadening of the scope of activities of the Office of Vocational Rehabilitation. Many of these employees, as a result of insanatorium and early postsanatorium instruction and training, will return to their jobs better qualified and more productive than they were before the onset of the disease.

### Stimulation With Minimum Power

Franklin Offner, Offner Electronics Inc., Chicago. In JOURNAL OF NEUROPHYSIOLOGY, 9:5:387, September 1946.

Varied wave-forms have been used for stimulating nerve and muscle, including sine waves, exponentially falling currents, inductive impulses (effectively a sum of exponentials), and square waves. Except where differential stimulation between several fibers is desired, the optimum wave-form is that which stimulates the fiber with least injury. Although the exact relationship between current, time, and damage has not been determined, it is probably proportional to the heat generated.

*Summary*

An exponentially rising current will stimulate nerve with least power. Such waves are not easily generated. A square wave of correct intensity only requires 22 per cent more power, and is easily generated. The exponentially falling current obtained from thyratron stimulators requires 85 per cent more power than the best current form. The use of square waves for stimulators and electric shock therapy is indicated.

### Therapy of Low Back Pain by Manipulation and of Referred Pain in the Lower Extremity by Procaine Infiltration

Janet Travell, M.D., and Willard Travell, M.D., New York. In ARCHIVES OF PHYSICAL MEDICINE, 27:9:537, September 1946.

*Summary and Conclusions*

1. The details of a technic for sacro-iliac manipulation are reviewed, and certain precautions to be observed in its use are presented.

2. The application of this manipulative procedure without anesthesia in over 400 selected cases of low back pain has had no known deleterious effects and in many instances has secured immediate and dramatic relief of pain and disability.

3. This manipulative technic, because of its simplicity, safety and effectiveness, warrants an early trial in the syndrome of low back pain.

4. A myalgic syndrome due to spasm of the gluteus

minimus muscle is described, which is a frequent complication of sacro-iliac displacement and which gives rise to the clinical picture of "sciatica."

5. The reference of pain from different parts of the gluteus minimus muscle was studied in 140 patients with lumbosacral pain and radiation of pain to the lower extremity by the technic of needling spontaneous trigger areas in the muscle.

6. Details of treatment of the gluteus minimus syndrome by infiltration of trigger areas with procaine hydrochloride or isotonic solution of sodium chloride are discussed.

7. Attention is called to the possible role of spasm of the pyriformis muscle in causing damage to the sciatic nerve, which has been observed as an infrequent complication of sacro-iliac displacement.

### Mobilizing the Quadriceps to Increase Active Movement in Stiff Knees

Captain M. Alexandroff, R.C.A.M.C., Toronto. In CANADIAN MEDICAL ASSOCIATION JOURNAL, 55:4:390, October 1946.

A method of operation for increasing the range of movement in stiff knees (quadricepsplasty) has been described by T. C. Thompson. In his article he states that it is beneficial for the patient to have had quadriceps-strengthening exercises prior to operation. I have drawn up a special program for patients with limited knee movement which resulted in only a few of the intractable cases requiring operation. It consists first of remedial exercises and secondly where necessary of novocaine injection and manipulation.

The purpose of the exercises is to: (1) reeducate quadriceps group; (2) increase size of this muscle group; (3) use the results for increasing the angle of active movement in the affected joint. Full results from this program in about 35 cases were not obtained because the remedial exercises instructors, who were carrying out the program, were removed from the hospital just as results were becoming apparent. However, it was evident that many of these patients, if given sufficient and supervised instruction on specific exercises, would be candidates for return to civilian duty.

*Summary*

1. There were no cases that did not gain active movement at the time of treatment by this method.

2. Eleven cases on follow-up show increase in the range of active movement following treatment.

### Peripheral Neuritis as a Complication of Penicillin Therapy

Commander Lawrence C. Kolb (MC) U.S.N.R. and Lieutenant Commander Seymour J. Gray (MC) U.S.N.R. In JOURNAL OF AMERICAN MEDICAL ASSN., 132:6:323, October 12, 1946.

Seven cases, which were observed within a six month period, suggest that penicillin may cause injury to the peripheral nerves with resultant sensory and motor disturbances.

*Case 2*—After treatment with physical therapy, complete recovery of function was observed three months after the onset of the palsy.

*Case 3*—The treatment consisted of physical therapy. Four months after the onset of the palsy, only slight evidence of weakness of the extensors of the toes remained.

*Case 6*—The patient was placed under treatment with light massage, and the arm was fixed in a neutral position by an airplane splint. At the end of April 1946, reexamination still disclosed evidence of atrophy and weakness of the previously mentioned muscles, although some voluntary contraction was present in the fibers of the anterior deltoid muscle. The patient had not been wearing his splint regularly, nor had he persisted with the physical therapy.

A diagnosis of neuritis of the right axillary and suprascapular nerves was made.

*Case 7*—Treatment was instituted by placing the arm in abduction and providing physical therapy and vitamins. The patient was seen on neurologic consultation December 12, at which time the only residual defect observed was a total loss of function of the serratus anterior muscle indicative of a persistent neuritis of the long thoracic nerve. No further recovery had taken place in this muscle as late as Feb. 6, 1946.

### Treatment of Fracture-Dislocations of the Proximal Interphalangeal Joints of the Fingers

Colonel Hartwin A. Schulze, M.C. (U.S.A.) In THE MILITARY SURGEON, 99:3:190, September 1946.

Although not mentioned in the textbooks and apparently not commonly known there is a simple manipulative treatment which is usually successful. This procedure consists in placing the joint into extreme flexion while making traction on the finger. This reduces both the fracture and the subluxation. In this position the joint is snugly bound by the tensed dorsal aponeurosis including the tendons of the extensor digitorum, the interossei and the lumbricales. The tonal tension of the flexor tendons also tends to prevent dorsal displacement.

Reduction is accomplished with little pain of but brief duration.

At the end of a week or ten days the finger is gradually extended while continuing immobilization of the joint and protective splinting. At the end of three weeks splints or dressings are no longer required and active and passive exercises can be instituted.

### Penicillin by Iontophoresis

Roy J. Popkin, M.D., Los Angeles. Correspondence in JOURNAL OF AMERICAN MEDICAL ASSN., 132:4:238, September 28, 1946.

Recently a report "The 'Ionization' of Penicillin," appeared in the British literature in which it was stated that penicillin could not be ionized.

This work confirmed my own observations in attempting to force penicillin across the normal skin by iontophoresis. One hundred thousand units of sodium penicillin was dissolved in 30 cc. of distilled water and applied in asbestos paper through the negative pole. The site chosen was the forearm. The subject was a normal young man. The current was gradually increased to a maximum of 20 milliamperes. The total time was fifteen minutes. Samples of venous blood draining the area were taken immediately after the fifteen minutes of application and fifteen minutes later. Only a trace of penicillin was found in the first sample and none in the second. This experiment was repeated at a later date except that this time the penicillin was applied through the positive pole. In the two samples of venous blood no trace of penicillin was found. Controls receiving penicillin by intramuscular injection showed appreciable activity each time. The broth dilution method with use of a sensitive hemolytic streptococcus was used in these assays.

As many men, especially oculists, are using penicillin by iontophoresis, it is felt that this additional information should be brought to their attention.

### Acute Instability of the Ligaments of the Knee As a Result of Injuries to Parachutists

Captain Robert M. Richman and First Lieutenant Kenneth O. Barnes, M.C. (A.U.S.) In JOURNAL OF BONE AND JOINT SURGERY, 28:3:473, July 1946.

Modern military training has greatly increased the incidence of traumatic instability of the knee. This has been especially evident at Fort Benning, a post devoted to advanced infantry training, where the violent combat exercises and obstacle courses in Officer Candidate School, as well as the hazards peculiar to parachute jumping, make injuries of the ligaments of the knee a source of many hospital admissions. These injuries are serious, not only from the point of view of the prolonged initial disability but also because of the high incidence of late symptoms. Too frequently, these patients complain of persistent pain, weakness and instability in their knees and show an increased susceptibility to joint effusions after subsequent trivial injuries. The present study was undertaken with the aim of minimizing these residual symptoms.

The literature on injuries to the ligaments of the knee is remarkable for the contradictions and divergent statements on all phases of the subject. Even the surgical anatomy is variably interpreted, as described by Brantigan and Voshell in 1941. Within the past five years, however, a number of outstanding investigations have crystalized certain facts from the mass of diversified opinions, and there is now general agreement on at least the following points:

1. The knee is a complicated weight-bearing joint with a combined hinge, gliding and rotary action.
2. The joint is supported by active muscle power, as well as by the ligaments.
3. The ligaments also serve to direct the muscle power.
4. The ligaments are mutually reinforcing and function as a team, so that the loss of a single ligament does not produce a major instability.
5. Solitary ligaments are rarely injured.
6. The knee should be considered as a functional unit.

This concept of the knee as a functional unit (the "physiologic joint" of Palmer) is fundamental. Much of the confusion in the literature can be traced to neglect of this principle and to preoccupation with the individual ligaments or elaborate surgical reconstructions, with insufficient emphasis on the ultimate functional recovery of the knee as a whole.

The purpose of this paper is twofold: first, to describe a new mechanism of injury causing instability of the ligaments of the knee; and, second, to report the results of conservative treatment in a large series of cases.

*Summary*

1. Eighty-five cases of acute instability of the ligaments of the knee were treated by conservative immobilization.
2. Most of the patients were parachutists, who tore the tibial collateral ligament of the left knee during the opening-shock phase of the parachute jump.
3. The plan of treatment consists in immobilization in plaster-of-Paris, supplemented with intensive exercises for the thigh musculature.
4. End results are evaluated on the basis of the functional capacity of the knee, according to specific clinical criteria.
5. The most reliable single index of disability is the amount of quadriceps atrophy. Rehabilitation of the shrunken quadriceps invariably improves the functional capacity of the knee.
6. Recovery of stability has been very satisfactory. Ninety-five per cent of the abduction injuries heal with less than 5 degrees of residual instability.
7. Calcification of the tibial collateral ligament is a frequent complication, but has not proved disabling.
8. Recovery of flexion and extension has been excellent.
9. Conservative immobilization has yielded excellent results in this series.

### Treatment of Poliomyelitis

Gordon M. Martin, M.D., Department of Physical Medicine, School of Medicine, University of Kansas, Kansas City, Kansas. In JOURNAL OF THE KANSAS MEDICAL SOCIETY, 47:9:396, September 1946.

Very early in the course of disease passive exercise to the point short of discomfort is started. This usually is carried out twice daily. If the patient can move actively without increasing his pain or spasm and without incoordination, he is encouraged to move himself from time to time in his bed.

At the end of the three weeks isolation period most of the patients will have only a moderate amount of residual pain and spasm in the muscles. They are then started on hydrotherapy and are treated in a warm bath with a water temperature maintained at 100 to 104 F. for periods of from 10 to 20 minutes daily. The use of the warm bath usually further relieves muscular soreness and tightness. Also the patient is helped and encouraged to actively use his weakened muscles.

The next stage in the treatment of these patients is to provide exercise that will increase the muscle strength. This usually depends on the use of more extended periods of active exercise and in some cases the use of resistive exercise. It is only through the use of resistive exercise that a muscle will increase in strength. In determining the amount of activity that a patient recovering from poliomyelitis can tolerate, it is important to remember that overfatigue or overstrain of a weakened muscle may result in a loss of strength in the neuromuscular unit, and a definite setback to the patient's progress.

The evaluation of the patient's physical capacities must be made from time to time by the orthopedist and the physical therapist. It is important to decide whether or not the patient can or should walk without braces. Often it is advisable to protect the joints of the weakened legs with braces which also make the patient more stable in his walking and standing.

In the chronic stages of the disease which may last for many years, the possibility of benefit to the patient by orthopedic surgical procedures must be considered. A transplant of a tendon of a strong muscle to assist the action of a moderately weakened muscle may give a patient much more stability. Occasionally progressive deformities of the spine may require fusion of the spine. If deformities are developing or have developed in the foot, surgical procedures for anthrodesing the foot and ankle must be considered. Most surgical procedures can be delayed until two years or more following the acute stages.

### Anterior Poliomyelitis

Robert O. Ritter, M.D., Senior Attending Orthopedic Surgeon, St. Luke's Hospital, Chicago, Illinois. In JOURNAL OF THE INDIANA STATE MEDICAL ASSOCIATION, 39:8:385, August 1946.

Individuals who are attacked by poliomyelitis are never cured; they recover, and what we do for them only assists in their recovery.

In the acute, febrile stage which lasts only a few days

the treatment is symptomatic. Bed rest in a quiet, darkened room is indicated. Sedatives should be given for restlessness or for pain. Prostigmine and curare have been recommended for relief of muscle spasm and contracture. Convalescent serum in the preparalytic stage may be given if the parents demand it or if the physician wants to give it. Many believe it has no specific value.

The stage of tenderness and early contractures begins after the fever subsides and lasts from three to six weeks or longer. During this stage the affected extremities are kept in neutral position by splints or casts. These may be removed at intervals and passive motion given. Warm baths or hot packs may be used. Massage in this stage may increase pain and contractures, and should not be used.

The convalescent stage begins when all tenderness is gone, and lasts from a few months to a few years. Muscle training by passive and active motion and underwater exercises may be used. The patient is allowed to be out of bed, and the affected muscles are protected by splints or braces. Muscle training is continued until no further improvement is shown.

The Kenny treatment is based on the theory that muscle spasm, muscle incoordination, and mental alienation are the cardinal symptoms. Miss Kenny says that this spasm and pain must be relieved before the persistent muscle spasm causes paralysis or muscle weakness.

The hot packs are of value in the acute stage as relief for pain and spasm. Miss Kenny uses continuous hot packs, passive motion, and one or two active movements twice a day until useful function is restored. She does not permit the use of splints or braces. To avoid any splinting effect, the joints are not included in the packs.

### The Problem of Meniscectomy in the Soldier

Lt. Col. W. Alexander Law, Royal Army Medical Corps. In JOURNAL OF BONE AND JOINT SURGERY, 28:3:496, July 1946.

Under Service conditions, injuries to the knee joint are as frequent as they are important; and they form a considerable source of sickness, with consequent hospitalization and loss of man power. A proportion of these injuries are meniscus lesions, and an attempt has been made in this series of cases to determine the value of operative treatment.

In a base hospital during the first six months of 1944, 120 "clean" knee-joint explorations were performed, and in 104 instances meniscectomy was carried out; of the remaining cases, missiles were removed from the joint in nine, loose bodies were removed in four, and nipping of enlarged infrapatellar pads of fat was found in three.

Careful selection of these cases was made in order to exclude those in which there were accompanying pathological changes—such as osteoarthritis, osteochondritis dissecans, undue laxity of collateral or cruciate ligaments, and gross wasting and weakness of the quadriceps muscle. These patients were regraded and treated by physical therapy. The object of operation, therefore, was to keep the soldier in his category—usually that of the fighting man—and to enable him to return to full duties as rapidly as possible.

The problem is not quite the same as in civil life, where the patient requiring a meniscus operation is very frequently the athletic young man of good physique, with muscular development above the average. The British fighting soldier, although physically very fit, does not always have the muscle power of the first-class athlete; and yet, in the course of his training and actual fighting, he is subject to stresses and strains on the knee joint far in excess of those encountered in ordinary recreational activities. It is reasonable, therefore, to anticipate the necessity for a longer rehabilitation period in the case of the fighting soldier than in his civilian counterpart.

The initial injury occurred while the patient was playing football in fifty-six cases (54 per cent); during military training or actual battle in twenty-three cases (22 per cent); and as a simple accident, such as a fall or while kneeling at work, in twenty-five cases (24 per cent). The strictly military causes included falls into bomb craters and diving for slit trenches (ten cases); jumping out of vehicles (three cases); blows from the starting handles of vehicles (four cases); parachute jumps (two cases); being caught and twisted in barbed wire (one case); and being blown over by blast (two cases). In one case a tiny missile had ripped the cartilage on its passage through the joint, and signs of internal derangement persisted until after meniscectomy, nine months later.

#### *Conclusions*

Meniscectomy is an operation of value in the soldier only in carefully selected cases of internal derangement of the knee joint. Under campaign conditions the operation is not justified in the presence of osteoarthritis, osteochondritis, or weakness of ligaments or muscles.

Total meniscectomy is preferable in order to exclude multiple meniscus lesions, and does not appear to cause excessive operative trauma to the joint.

Preoperative and postoperative physical therapy are of as great importance as operative technic.

The majority of patients can be expected to be fit for duty within two months after operation, but in actual practice, for troops in the forward area, three months' absence from the unit is to be expected.

### Rehabilitation of the Injured Hand

Lieut. Comdr. Sidney Baron Hardy, (M.C.) U.S.N.R. Plastic Surgery Service, U. S. Naval Hospital, St. Albans, Long Island, New York. In AMERICAN JOURNAL OF SURGERY, 72:3:352, September 1946.

Bunnell makes the statement: "Next to the brain the hand is the greatest asset to man, and to it is due the development of man's handiwork."

Certainly during this last war man has perfected much varied and mechanized equipment all demanding some degree of manipulation by hand and this, in turn, has increased the incidence of hand injuries. The instinct to protect one's face and to use the hands to help one to safety in the face of danger also subject them to a greater probability of injury. Indeed, it is hard to conceive that a person could be injured in combat who would not receive also some injury to his hands due to this instinct to protect himself. Injuries due to these causes augment the large number of hand injuries sustained in combat as the result of direct enemy fire.

#### *Comments*

Rehabilitation of the injured hand is in most instances probably one of the most difficult tasks which the surgeon is called upon to perform. By careful examination and planning, together with meticulous surgery, this work can be accomplished with satisfactory results in many cases. Good cooperation on the part of the patient in taking active hand exercises and following physical therapy treatments is most essential for good results.

### Rehabilitation of the Surgical Patient in Army Hospitals in World War II

Colonel Augustus Thorndike, M.C. (A.U.S.). In AMERICAN JOURNAL OF SURGERY, 72:3:404, September 1946.

Among the interesting developments of surgery of the recent war and evident as of interest in prior wars was the importance of developing as part of medical treatment a planned program of convalescent reconditioning. The forgotten surgical patient in civil practice is he who has been discharged from the hospital to the home care of relatives for the convalescent period. The Surgeon General in 1943 fully appreciated the problem relative to the soldier patient, who, when discharged from the hospital, must be physically fit to report for a full day's military duty or discharged to civil status fit to assume the full responsibilities of independent economic life.

With a good program of convalescent reconditioning, many patients have been returned to full military duty that otherwise would only have been capable of performing limited duty; and, furthermore, large numbers have been salvaged for limited duty that otherwise would have been discharged to civil life. In the recent war 58.8 per cent of the wounded were returned to military duty within the overseas theaters—an important number of military personnel too have been salvaged. The best results have been reported from the Convalescent Centers of the European Theater where 84.5 per cent of the patients were returned to duty within the theater.

### Factors Influencing Callus Formation in Open Fixation of Fractures

Jean Verbrugge, M.D., Antwerp, Belgium. In JOURNAL OF BONE AND JOINT SURGERY, 28:3:535, July 1946.

The object of this paper is to consider the factors which, due to the surgeon's operative interference, may influence the speed of formation of callus and its quality and quantity. Only the factors related to surgery are considered, and not the nature of trauma, the location of the fracture, the state of health of the patient, or his age. A presentation of the still widely discussed theories on the histology and biology of bone formation is not included. Due to circumstances, proper illustrations and statistical data are, unfortunately, lacking.

*Other Factors Influencing Callus Formation*

The other factors to be mentioned all concern the speeding up of bone formation; they are only worthy of consideration if the two basic factors, reduction and fixation, have been carried out perfectly. Most of them deal with the increase of the blood supply.

*Early Function*—Early function is a basic factor which is only practical if no plaster has been applied. It can be carried out soon (fifteen days after reduction) in the upper extremities. It is the same for the lower extremities, but here the real function consists in weight-bearing, and the time such function should start varies according to the roentgenographic findings.

*Sympathectomy or Ganglionectomy*—Sympathectomy or ganglionectomy is useful only if block anesthesia with procaine hydrochloride indicates definite improvement. Its value is temporary and not constant.

*Massage*—Massage may be harmful and may provoke marked reaction of the bone, as well as of the soft tissues. If it is applied gently, it may help in relieving muscle spasm.

*Tapping*—Tapping the site of the fracture or the extremities of the fractured limb will stimulate circulation of blood and hasten the formation of callus. Its effect is negligible, however.

*Short-Wave Rays*—These may stimulate the circulation if used in small amounts, but the danger of provoking resorption of bone outweighs their value.

*Calcium*—The oral administration of calcium, alone or in the diet, is inefficient. Calcium, injected intravenously or into the fracture area, does not seem to be popular among orthopedic surgeons. Neither does the injection of the serum of patients with fractures.

*Other Drugs*—Parathormone and vitamin D have been advocated. The author has had no experience with them.

Bogomolets, in 1943, suggested the use of an "antireticular cytotoxic serum," produced by inoculating horses with cells of the spleen and bone marrow taken from fresh human cadavera. He claimed that in small doses the serum has a valuable effect on the speed of bone formation. The author has had no experience with it.

*Conclusions*

In the treatment of fractures, surgeons are striving for the optimum type of callus, exactly as they aim at obtaining a perfect skin scar.

The characteristics of an optimum callus are: (1) rapid formation; (2) its quality (solid homogeneous bone); and (3) its quantity, which should be neither large enough to interfere with function (a large callus corresponds to a keloid) nor too small.

Surgeons have at their disposal most of the means of reaching their aim. The most important ones depend upon themselves, their principles, their methods, and their technic—the "timing," the perfection of reduction and immobilization, the discriminating use of bone grafts, and so forth. In spite of attention to all these factors in particular cases of old fractures, surgeons will be confronted with a lack of response on the part of Nature; the bones "won't heal." (This should be the object of more research; and the author suggests the study of vaccines and of resorbable alloy.) All the means of effectively increasing the local supply of blood will be of help.

### Repair of Avulsion Wounds of the Hands and Feet by the Flap Graft Technic

Major Leonard R. Rubin, M.C. (A.U.S.) Chief Plastic and Maxillo Facial Surgery, 37th General Hospital, The Kings County Hospital (Brooklyn) Affiliate. In AMERICAN JOURNAL OF SURGERY, 72:3:373, September 1946.

The treatment of avulsion wounds of the hands and feet in a general hospital functioning in the Mediterranean theater of operations during World War II presented definite problems which necessitated a closure technic providing a thick fatty skin cover within the shortest period of time. All of these wounds were either penetrating or perforating; tendons, nerves and bones were exposed. In most cases the bones were fractured and often fragments were missing. While many of the cases were clinically clean immediately after debridement at evacuation hospitals, all were contaminated and many were infected by the time the general hospital was reached. Unless covered with a skin layer early, exposed tendons and bones soon became necrotic. To prevent further loss of the deep tissue structures, and to provide for the earliest functional results, all skin grafting technics were investigated.

*Summary*

1. Forty-nine cases of flap graft closures were performed for deep wounds of the hands and feet, with good functional results.

2. The very early cover of exposed infected tendon

and bone is advocated by the use of this technic.

3. The flap graft technic is quick and sure of take in covering wounds of the hands and feet with a fat-containing skin cover.

4. The principles of multiple blood transfusions and penicillin therapy are believed to be important adjuncts in the graft take.

5. Early physical therapy for optimal function is a full time job for a trained nurse or assistant who understands the problems.

### Complications of Colles' Fractures

Lenox D. Baker, M.D., and Howard J. Schaubel, M.D., Durham. In NORTH CAROLINA MEDICAL JOURNAL, 7:9:457, September 1946.

*Avoidance of Complications Resulting from Disuse*

Disuse of the injured extremity leads to loss of joint motion and causes more disability than does the original injury. To avoid these complications, the patient should be taught one or several exercises immediately following reduction of the fracture. (By "immediately" is meant before the patient leaves the fracture room following the reduction.) Limitation of motion in the shoulder, elbow, and finger joints is the result of improper treatment and not of the injury. There are several groups of exercises that may be used to insure complete motility of these joints. Any or all of these exercises can be used with satisfaction provided the patient is cooperative. One of the simplest exercises for the shoulder is circumduction with gravity eliminated. This is carried out as follows: As the patient supports a part of his weight with the uninjured hand on a table or the back of a chair, he bends forward sufficiently to allow the injured arm to hang perpendicularly. The shoulder is then carried through full circumduction. At first it may be necessary for the patient to have some assistance; this can be given by a nurse or a member of the family.

A simple exercise for the fingers can be supplied by allowing the patient to squeeze a soft rubber ball. This ball should be a bit smaller than the ordinary tennis ball and should be much softer.

There are several simple exercises which involve the use of all free joints of the injured extremity. In this exercise two glasses or capped jars containing different colored fluids are used. One is placed on a shelf in easy reach above the patient's head, the other on a table. The exercise consists in interchanging the places of the glasses a given number of times according to instructions. This exercise develops finger motion and grip, and carries the shoulder and the elbow through full ranges of motion.

### The Treatment of Poliomyelitis Under Orthodox, Kenny, and Prostigmine Methods

George J. Boines, M.D., Physician in charge, Kenny Clinic, Doris Memorial Unit, Wilmington General Hospital, Wilmington, Delaware. In DELAWARE STATE MEDICAL JOURNAL, 18:8:167, August 1946.

In October 1941, we became interested in the Kenny concept of infantile paralysis and in the treatments as outlined by Miss Elizabeth Kenny in Minneapolis and later in Wilmington. As stated before, with the Kenny method of treatment we noticed unusual improvement: no deformities, no stiff joints, no contractures, early convalescence, happy patients, and what also is very important, happy families who were able to take their patients home after a comparatively short period of hospitalization.

Kabat and Knapp reported on the action of prostigmine on subacute and chronic poliomyelitis patients who were also receiving hot packs. Their results were very encouraging. It was noted that the drug had the ability to relax muscle spasm and improve incoordination and alienation in the subacute and chronic cases who did not respond to the hot packs alone. Inspired by this work, we decided to use prostigmine without hot packs on acute, subacute and chronic cases. This work was reported in a previous communication. We showed that this parasympathicomimetic drug could be used as a substitute for the hot packs, and that additional and substantial relaxation of muscle spasm was obtained in chronic patients who had formerly received the Kenny hot packs over a period of many weeks. It was also noted that patients who had been formerly treated by other methods over a period of years made spectacular improvement with prostigmine. Kenny muscle reeducation was used in all the patients.

We now present the results of the treatment of 157 cases of acute poliomyelitis treated in the five-year period of 1941 to 1945, inclusive.

*Conclusions*

The best method of handling acute poliomyelitis at the present time is that based on the Kenny concept of the disease, using hot packs and prostigmine in order to relax muscle spasm, incoordination and alienation, and using Kenny muscle reeducation, functional rehabilitation, and occupational therapy.

### Treatment of Extremities Following Sudden Failure of Circulation

Gordon Murray, M.D., J. S. Simpson, M.D., and N. A. Watters, M.D., Toronto, Canada. (From the Department of Surgery, University of Toronto, Toronto General Hospital). In SURGERY, 20:3:315, September 1946.

There is much evidence to indicate that the orthodox method of treatment of acute failure of circulation such as occurs in embolism, diabetes, senile or Buerger's gangrene, or injuries to major blood vessels and frostbite, might be revised to advantage. The textbook treatment of such conditions, namely, elevation, heat, and mild antiseptic dressings, is a survival of the past, antedating Harvey's discovery of circulation of the blood and the increased knowledge of physiologic principles. Sydenham's recordings of the practices of Hippocrates indicate that in 410 B.C. he used the methods just described. It is probably fair to assume that Hippocrates did not know the physiology of circulation as we know it. His object in treatment was to hasten the formation of the line of demarcation and to facilitate the natural separation of the gangrenous from the adjacent living tissue, and his principles of elevation, and application of heat and embalming herbs, which are the textbook methods of treatment today, were quite effective in precipitating a pregangrenous condition into frank gangrene with the result which he desired. With the present knowledge of physiology, it would seem that the application of rational principles might prevent the advance of a pregangrenous condition and might set up conditions which would favor a return of circulation and survival of the part.

*Conclusions*

In extremities with impaired circulation the best prospects for survival can be provided by keeping the extremity dependent, by the application of cold, and by using methods to effect maximum dilatation of the collateral vessels entering the extremities.

## The Role of Galvanism in the Treatment of Denervated Voluntary Muscle in Man

Shirley Jackson, Wingfield-Morris Orthopedic Hospital.
In BRAIN, 68:4:300, December 1945.

Although the effect of galvanism on the structure and shrinkage of denervated muscle has been very thoroughly investigated experimentally, there is little, if any, direct evidence derived from observations in man. Doupe, Barnes and Kerr (1943) investigated its effect in man indirectly by studying the rate of recovery of muscles treated with and without galvanism after suture of the radial nerve. Their results suggested that galvanism was ineffective, but the criterion chosen was one which might have been affected by factors other than galvanism, and animal experiments suggest that the dosage used by them—15 to 30 moderate contractions five to six times a week—is one which, although it is in common use clinically, is too small to be effective; in consequence the clinical application of galvanism is still a controversial matter.

It therefore seemed likely that galvanism might prove valuable in the treatment of peripheral nerve injuries, but in clinical practice there are certain conditions not found in the animal experiments:

(1) The muscles to be stimulated are much larger than those in the rabbit or rat, and therefore are more difficult to exercise adequately.

(2) Frequent and prolonged treatment is probably required, but a man may be obliged to return to work during the long period when he is waiting for recovery to occur.

The purpose of this present work is to determine:

(1) Whether or not electrical treatment, such as can reasonably be given clinically, produces any beneficial effect.

(2) If so, what is the effective dosage and frequency of treatment.

(3) Whether the effect justifies the time spent by the patient in receiving treatment.

(4) When the treatment should begin.

(5) How long it should continue.

### *Discussion*

The results of these observations are of necessity less accurate and informative than those of animal experiments, which include weighing and histological study of muscle. It is inevitable that with the methods used here any change in volume due to decrease in blood flow or to shrinkage of the skin and subcutaneous tissue will be recorded in addition to the muscle atrophy and this change might be considerable in a patient with both median and ulnar lesions. Furthermore there are obviously considerable variations in the volume of muscles in relation to the bulk of the whole hand, and a very large number of cases would have to be examined to eliminate this factor. Nevertheless, the method is reliable enough to establish certain facts, which are in keeping with the results of the most reliable animal experiments. They are, briefly, these:

(1) After denervation the volume of the hand decreases whether or not it is treated with galvanism.

(2) The rate of wasting is greatest early after denervation, but gradually falls off.

(3) If galvanism is not used, wasting continues until about 400 days. After this time there is no significant decrease in volume; atrophy is maximal.

(4) If galvanism is used, the rate of decline in the 0-100 day period is significantly reduced.

(5) If galvanism is used, the decline in the volume of the treated hand ceases in the period 100 to 200 days and thereafter.

(6) Recovery of function is probably better in muscles in which wasting has been retarded.

(7) It appears that recovery of function is hastened when galvanism is given.

(8) During immobilization wasting is largely prevented by galvanism, but the rate of wasting without galvanism appears to be increased when the limb is immobilized.

### *Summary and Conclusions*

In the treatment of peripheral nerve injuries one problem is to maintain the denervated tissues in good condition so that when reinnervation occurs recovery of function will be as good as possible. In animals the condition of the muscle has been shown to be favorably influenced by galvanism.

This investigation was designed to show the effect in man of such treatment as can reasonably be given clinically. Groups of patients with ulnar nerve paralysis have been treated with and without galvanism and the progress of wasting in the hand has been followed. The wasting has been measured volumetrically by immersing the hand in alcohol up to a constant level on the wrist and weighing the displaced fluid. Changes in bulk of the hand but not the absolute amount of wasting of muscle can be measured by this method. Changes in the bulk of the hand with and without galvanism have been studied (1) during denervation without immobilization, (2) during denervation with immobilization, and (3) during reinnervation.

The following conclusions have been reached:

(1) The volume of the hand is subject to considerable variation but large changes are brought about only by abnormal conditions such as heating the body to produce a high degree of vasodilatation. The variation in volume due to normal influencing factors such as manual work and small changes in temperature is not large, but it means that a single reading is not entirely reliable. There is, however, a direct if not absolute correlation between the changes in volume of the two hands of the same subject. An adequate correction for the normal variation in the volume of the paralyzed hand may therefore be made by measuring the volume of the normal hand as well.

(2) For a short period after denervation the volume of the hand decreases whether or not galvanism is given. The rate of decrease is greatest early after denervation and gradually becomes less as time goes on.

(3) When no galvanism is used wasting continues for about 400 days; after this time the volume remains constant.

(4) If galvanism is used the rate of wasting is decreased in the period 0 to 100 days and wasting ceases in the 100 to 200 day period and thereafter.

(5) Recovery of function is probably better in muscles in which wasting is slight and galvanism appears to aid voluntary action of the muscle when given at the time of reinnervation.

(6) Immobilization appears to increase the rate of wasting when galvanism is not given, so that the decrease in wasting attributable to galvanism is even greater than when the limb is free.

(7) In the few children studied recovery of power and increase in bulk were satisfactory whether or not galvanism was given.

(8) The findings support the use of galvanism in the care of denervated muscle but to be fully effective, treatment should be without a break and adequate in in-

tensity, duration, frequency. These results have been obtained from the treatment of small muscles; the behavior of larger muscles may prove different.

### Psychosomatic Aspects of Arterial Hyptertension

Edward Weiss, M.D., and Morris Kleinhart, M.D., Philadelphia, Pa. In PENNSYLVANIA MEDICAL JOURNAL, 49:12:1321, September 1946.

*Summary and Conclusions*

The organic tradition in medicine has been responsible for a narrow view of the etiology and treatment of essential hypertension. The psychosomatic approach does not neglect the physical problems involved, but includes a consideration of the role of the emotions. It does not mean to study the soma less; it means to study the psyche more. It emphasizes the multiple factors in etiology and pathogenesis and attempts to evaluate the resulting composite clinical picture. Such studies indicate that emotional factors apparently are intimately related to the development of hypertension in some patients, to the production of symptoms in many others, and enter into the question of treatment in nearly all patients with essential hypertension.

A common problem seems to be the presence of emotional tension due to chronic repressed hostility. This inhibited aggression (chronic rage) seems to bear a definite relationship to hypertension, and if it can be relieved by means of psychotherapy, anxiety is diminished and blood pressure is often lowered. Even if the blood pressure is unaffected, the treatment usually benefits the patient by making him a healthier and more effective personality. Our objectives in treatment should be readjusted. We must not limit our efforts to "bringing the blood pressure down." There is no reason why we cannot combine physical (medical and surgical) methods with psychotherapy, but we must go beyond the physical aspects of hypertension to the personality of the hypertensive individual in order to be successful in the management of such patients.

### Inappropriate Treatment of Moles Predisposing to Melanotic Malignancies

P. S. Putzki and J. H. Scully. In MEDICAL ANNALS OF DISTRICT OF COLUMBIA, 15:320, July 1946.

Putzki and Scully say that within the past few months they have seen 3 cases of malignant melanomas which have followed the electrodesiccation of moles believed to be innocent growths. They present these cases to reemphasize the danger and tragic consequences which may follow the destruction of moles by heat, electrodesiccation, inadequate cauterization and the use of chemicals, caustics, solidified carbon dioxide, pastes, acids and the like. In the cases described the moles on the face and neck were removed by electrodesiccation. Two of the 3 reported cases ended fatally. Moles subject to irritation by clothing, shaving, combing the hair or inappropriate treatment with heat, caustics and the like may and frequently do undergo transition to a malignant state because of this irritation and stimulation. Moles showing activity such as increased pigmentation, vascularity, bleeding, ulceration and growth should be radically excised. Once metastasis has occurred the prognosis is grave, regardless of treatment. Roentgen therapy holds little promise. Hope of reducing the high mortality of malignant melanomas lies in early diagnosis of moles undergoing change and thorough excision of the primary lesion before dissemination takes place.

### The Relation of Electric Potential Changes to Contracture in Skeletal Muscle

Stephen W. Kuffler, Kanematsu Institute, Sydney Hospital, Sydney, and Department of Physiology, The University of Chicago. In JOURNAL OF NEUROPHYSIOLOGY, 9:5:367, September 1946.

For the purpose of this study contracture may be defined as a prolonged, reversible, not conducted contraction of a muscle. The extensive literature on this subject has been surveyed by Gasser in a critical and comprehensive review. The aim of the present investigation was to record the electrical potential changes which accompany contracture, and to study the role which the muscle membrane plays in initiating and maintaining the processes of contraction. Potentials during contractures have already been recorded by Biedermann and other workers and more recently by Bremer. In investigations on the whole muscle, however, it is difficult to record accurately from the site of the contractures. Further, it is not always possible to distinguish electrically propagated from local contractions when they occur simultaneously. Such difficulties have now been largely overcome by using completely isolated muscle fibers. Contractures were produced by constant current pulses and by chemical stimulation.

*Summary*

Experiments were performed on nerve-muscle fiber preparations of the M. adductor longus and on whole isolated sartorius muscles of frogs (Hyla aurea). Contractures were set up by constant current pulses and by application of drugs.

1. Negative potential changes are always recorded at the site of origin of contractures in isolated muscle fibers.

2. Contractures, like propagated muscle responses, are initiated, after a sufficient depolarization of the muscle membrane. Contractures may arise: (i) following on muscle impulses which may gradually fail to propagate fully from the region of their origin. In these preparations a transition can be detected from normal to "abortive" impulses and to a maintained negative potential change which may give rise to contractures without appreciably exceeding the potential level at which the preceding propagated responses had been set up; (ii) not preceded by propagated responses following on the depolarizing action of drugs or currents in fatigued, narcotized or injured muscles.

3. Contractures set up by chemical application are actively maintained by the depolarizing action of drugs. This action is analogous to the "cathodic shortening" effect which lasts for the duration of the current flow. "Chemical" or "electrical" contractures can be graded, depending on drug concentration or current strength.

4. Relaxation of chemically produced contractures can be effected at the anode of constant currents.

5. Novocaine does not raise the threshold at which contractures are set up by constant currents or by potassium application. The apparent threshold for brief shocks, however, is greatly increased. The electric time constant and the resting potential of the muscle membrane is not significantly affected.

6. The connection between the muscle membrane and the contractile elements is discussed. It is suggested that the action currents which accompany depolarization or the propagated muscle impulse are not the essential link in the transmission of "excitation" from the membrane to the contractile elements.

### Electromyographic Studies of Muscular Coordination on Stimulation of Motor Cortex

James F. Bosma and Ernst Gellhorn, Laboratory of Neurophysiology, Dept. of Physiology, University of Minnesota, Minneapolis. In JOURNAL OF NEUROPHYSIOLOGY, 9:4:263, July 1946.

The relation of agonist to antagonist in voluntary movements is controversial. Some authors such as Watkins are inclined to consider simultaneous activity of flexors and extensors ("co-contraction") as a pathological symptom frequently seen in poliomyelitis, whereas others emphasize its occurrence in normal individuals. As a physiological foundation for the understanding of the mechanisms of muscular coordination under conditions of voluntary innervation, a detailed knowledge of the function of muscles following electrical stimulation of the motor cortex is of value.

*Summary*

Experiments were performed on the effect of stimulation of the motor cortex of cats and monkeys on muscular coordination by means of electromyograms of flexor and extensor muscles. It was found that the effects depend on duration and intensity of stimulation as follows:

1. Very weak stimulation of the motor cortex causes relaxation of flexor and/or extensor muscles if a prestimulatory tonic activity is demonstrable in the electromyograms. Such cortically induced inhibition is frequently followed by a poststimulatory rebound.

2. With slightly increased intensity which calls forth a movement (flexion or extension), reciprocal innervation of agonist and antagonist may be observed whereas somewhat stronger stimuli cause simultaneous activity in flexor and extensor muscles, i.e., co-innervation, and consequently co-contraction, during flexion or extension.

3. Variations in the duration of the period of stimulation exert effects similar to those seen in experiments involving different intensities. Whereas reciprocal innervation appears during the early phase of stimulation it is later followed by co-innervation while the stimulation continues.

4. Even the agonist may show a transition from inhibition to excitation during stimulation at constant frequency and intensity.

5. It is shown that an inhibitory period frequently occurs on cessation of stimulation.

6. The phenomena described under 1-5 are interpreted as indicating that with increasing number of discharging neurons the peripheral effect on individual muscles changes from inhibition to excitation, and in the case of an antagonistic pair of muscles, from inhibition to reciprocal innervation, and finally to co-innervation. Under conditions permitting facilitation the predominant type of coordination of fore- and hindleg muscles in flexor and extensor movements of moderate intensity is that of co-innervation.

### Stabilizing the Knee Joint Through Thigh Muscle Development

Fourth Paper of a Series by Henry Funk, B.A., M.D., Ch.M. Demonstrator in Orthopedics, University of Manitoba, Orthopedic Consultant in Ninette and St. Boniface Sanatoria. In MANITOBA MEDICAL REVIEW, 26:7:403, July 1946.

Inasmuch as the first line of defense of a joint is its muscles and the second line its ligaments, it immediately becomes apparent that the integrity of a joint is dependent primarily on the muscles which act upon it, with the ligaments coming into play mainly when the muscles are inactive.

This premise conveys numerous implications and it is quite evident that if the muscles acting on the knee joint become weakened as a result of injury, disuse or disease, the stability of the joint will be impaired. If, for example, the lower limb is encased in a plaster cast to immobilize a fracture and the thigh muscles are not used actively, then weakness ensues. Removal of the cast after a period of weeks or months will demonstrate marked impairment of function of the knee joint. This is partially due to the prolonged immobilization but chiefly to the thigh muscle weakness. Even noninclusion of the knee joint does not completely guard against such weakness, although impairment of function will be less if the cast has been a walking cast permitting some active use of the muscles.

Activating and redeveloping the strength of the thigh muscle is of wide application. The contraindications apply wherever rest of these muscles is imperative, e.g., the earlier stages of union of a fracture of the femur, repair of these muscles, fractures about the knee joint where active contraction will disturb the alignment, inflammatory processes, etc. In addition to pre- and postoperative indications, osteoarthritic knee joints are greatly stabilized and often rendered painless by redeveloping or overdeveloping thigh muscle strength and the necessity for wearing a brace or operative measures may be obviated. Similarly, injured cruciate and collateral ligaments need not be the source of much disability if the muscle strength is well developed. When fracture union has progressed to the point where muscle contraction will not disturb the position of the fragments, quadriceps exercises are indicated. Even in injuries below the knee, as in the foot, which prevent partial or complete weight bearing, the patient can by exercises prevent muscle weakness, and the circulation of the limb also can be kept in a much better state.

Having maintained the muscle strength throughout the period of convalescence the patient never knows how much benefit he has derived from these exercises and the attending physician will be gratified by the rapidity with which such an individual becomes restored to usefulness.

Development of the muscles acting on the hip joint have been purposely omitted, since these muscles do not act directly on the knee joint. But they also can readily be exercised by applying a similar principle. Where a prothesis is to be fitted all groups of muscles should be developed preparatory to the fitting.

### Physical Methods in the Treatment of So-Called Psychosomatic States

Geoffrey Evans, M.D., F.R.C.P., Physician to St. Bartholomew's Hospital, London. In BRITISH JOURNAL OF PHYSICAL MEDICINE AND INDUSTRIAL HYGIENE, 9:4:100, July-August 1946.

In my experience I have found that the methods of physical medicine, in some form or other, have their application to nearly every sick person. My present object is to discuss the value of physical methods in the treatment of psychosomatic and psychoneurotic disorders and, in so doing, to consider some of the physiological and clinical principles involved in this physical approach to the psyche. Whereas there cannot be any question of the divorce of body and mind, nevertheless there is a present tendency to attribute most functional disorders to a central disturbance or imbalance. In fact, psychologists and psychiatrists have so far advanced their subject in recent years that it is largely assumed that the first approach in treatment of psychoneurotic and

psychosomatic disorders is necessarily on psychological lines.

*Conclusions*

It may seem that I have covered a wide field of medicine and that some of it is outside the scope of practitioners of physical medicine. If this is so, then I should like to take the opportunity of saying that I believe that physical medicine has something to contribute to almost all people who are ill; that in certain cases their recovery will be entirely in the hands of its practitioners whereas in others they will be contributing to the health of vital processes, such as respiration, circulation and digestive function, the perfect functioning of which will accelerate and possibly determine recovery. Furthermore, I believe that anyone who practices physical medicine must have an understanding of the psychological aspects of disease and also something which is more important—a real understanding of the ordinary human mind.

### Treatment and the Results of Treatment in Anterior Poliomyelitis

Shelby G. Gamble, M.D., Director, Dept. of Physical Medicine, Ohio State University College of Medicine. In OHIO STATE MEDICAL JOURNAL, 42:8:831, August 1946.

It is realized that there are many manners and means of treating anterior poliomyelitis. Since this condition is generally accepted as being a virus disease, it must be understood that to date there is no specific therapy known, drug or otherwise, that destroys the virus or controls its spread within the body. In other words, one cannot prevent the development of, or lessen the severity of, paralysis in a patient by any means known at present.

*Physical Therapy*

The convalescent stage is primarily one of good physical therapy. The object of treatment with patients with definite residual is to keep the joints limber, keep the muscles in good general condition as far as possible while waiting until the innervation returns if this is to occur, and to prevent deformities and contractures. This is not always possible with the best of care, as occasionally deformities, etc., are progressive no matter what is tried. However, the general statements made are true in the average case, as most patients show varying degrees of improvement over the original weakness or paralysis; provided, of course, as stated above, that the motor cell is not completely destroyed.

The paralysis and weakness in poliomyelitis is spotty which is typical of the involvement. By nature of this irregular involvement, changes will occur at irregular intervals so that no set routine can be followed. Instead patients must be examined and observed frequently.

The convalescent period is one of rest, passive, assistive and active exercise both in and out of water, muscle reeducation and the avoidance of muscle substitutes. It is one of gradual ambulation and increased activity as indicated. Braces, corsets, crutches, etc., may or may not be indicated depending upon the individual case. Such apparatus when necessary is always obtained through conference with and ordered by the orthopedic surgeon in attendance on the case. A certain amount of muscle power is essential to perform certain tasks or use certain apparatus. However, in general, muscle balance and coordination are of prime importance—not strength. Reeducation of muscles requires a great deal of patience and perseverance on part of the patient, the family, and all persons related to the treatment program. Even though muscles may appear normal early in the program, there is not the normal reserve present so that fatigue is an important factor to be avoided.

*Summary*

The results of treatment, of course, depend upon the degree of weakness or paralysis that is present. There is no specific agent as far as we know that will lessen the degree of paralysis that a patient may have from their infection. Basically everything depends on the degree of involvement of the anterior motor horn cell. Much can be done however to keep muscles and joints in good condition and prevent deformity while waiting the return of function of the motor cell. If this occurs completely, the period of care is then markedly shortened. If the return of function is only partial, a varying amount of help can be given so that the patient may be able to use whatever apparatus is necessary, or on the other hand be in good general as well as local condition as a preparatory measure to corrective orthopedic surgery. As a broad statement, treatment programs today leave a patient in a far better general over-all condition than some years back. The results today show the effect of scientific physical therapy and judicious orthopedic surgery when a patient can be controlled and treated properly which includes adequate follow-up. Last, but not least, in consideration of results, is an intelligent patient with a will to improve, a cooperative family, and means of social and economic rehabilitation so that a patient has something to look forward to. This is an aspect of the problem of anterior poliomyelitis, too large in scope for our present consideration, and is only mentioned because of its importance in your thinking.

### Studies in the Mechanics of Synovial Joints: II: Displacements on Articular Surfaces and the Significance of Saddle Joints

M. A. MacConaill. In IRISH JOURNAL OF MEDICAL SCIENCE, 247:223, July 1946.

*Summary*

(1) Articular surfaces are classified as ovoid and sellar.

(2) Experiments upon joints and model surfaces are described.

(3) The results of these experiments are shown to be predictable from a simple theorem of the general geometry of surfaces.

(4) The mechanics of circumductions is examined. It is shown that saddle (sellar) surfaces are mechanically more efficient than ovoid surfaces for bringing about rotations combined with circumductions.

(5) Examples of the working of the last principle are drawn from joints of the hand and foot.

### Medical Implications of Convalescence

Major Richard W. Lippman (MC) A.U.S. In ARCHIVES OF PHYSICAL MEDICINE, 27:8:477, August 1946.

*Summary*

1. Stress has been placed upon the medical and social implications of convalescence.

2. The physician's responsibility in the management of convalescence has been outlined.

3. The significance of disuse atrophy to the integrated organism and the physiologic abuses of rest have been discussed.

4. Suggestions are made concerning the constructive intellectual uses of convalescent time.

5. Attention is directed to the success of the Army's reconditioning program, which has shown that considerable improvements in convalescent care may be made through a conscientious and well organized approach.

**Tinea Capitis: Its Treatment with Special Iodine and Dilute Acetic Acid**

Albert Strickler, M.D., Medical Director, Hersch-Razel Research Foundation, and Medical Director, Skin and Cancer Hospital of Philadelphia. In JOURNAL OF AMERICAN MEDICAL ASSOCIATION, 132:2:65, September 14, 1946.

The principles involved in this method concern the use of iodine, a remedial agent acknowledged as definitely fungistatic and to a degree fungicidal for the ringworm fungus, and the enhancement of this activity through the application of photosynthesis, whereby it is assumed that the iodine molecule became a more active molecule (an activated molecule).

In the combined series of 115 children with tinea capitis, 74 patients (64 per cent) were cured as determined by three successive direct negative examinations and by three negative inspections of the scalp hair under filtered ultraviolet light.

## Book Reviews

**Injuries of the Knee Joint.** *By I. S. Smillie, O.B.E., M.B., F.R.C.S. (Ed.), F.R.F.P.S., Surgeon-in-Charge, Orthopedic Hospital, Larbert, Stirlingshire; Consulting Orthopedic Surgeon, Industrial Fitness Center, Gleneagles, Perthshire; Honorary Director of Orthopedic Department, Falkirk and District Royal Infirmary; Member of the Advisory Committee on Rehabilitation of the Miners' Welfare Commission. Cloth. Price, $9. Pp. 320, with 350 illustrations. Baltimore: The Williams and Wilkins Company, 1946.*

This is an important book for industrial surgeons. It discusses fully injuries of the knee joint as traumatic synovitis and hemarthrosis, the surgical anatomy, physiology and surgical pathology, of the menisci and mechanism of their injuries; clinical features of internal derangements of the knee joint relative to the menisci; treatment, after treatment and complications of injuries of menisci; injuries of ligaments, injuries of extensor apparatus, fractures of the tibia and femur involving the knee joint, loose bodies of traumatic origin, foreign bodies, wounds of the knee joint and surrounding tissues, and the stiff knee.

Physical therapists will be interested in chapter one on the importance of the quadriceps and quadriceps exercises.

**The Challenge of Crutches.** *By George G. Deaver, M.D., Medical Director, Institute for Crippled and Disabled, and Mary Eleanor Brown, M.A., Physical Therapist, Institute for Crippled and Disabled. Paper. Price, 50c. Pp. 159. New York 10, N. Y.: Institute for Crippled and Disabled, 400 First Avenue, 1946.*

This pamphlet contains the following parts originally published in the "Archives of Physical Medicine": (1) Methods of Crutch Management. (2) Crutch Walking: Muscular Demands and Preparation. (3) Standard Crutch Gaits and How to Teach Them. (4) Prescribing Crutch Gaits for Orthopedic Disabilities. (5) Daily Activities on Crutches.

**Health Instruction Yearbook, 1946.** *Compiled by Oliver E. Byrd, Ed. D., Associate Professor of Hygiene, Stanford University. Foreword by C. E. A. Winslow, Dr. P.H., Professor Emeritus, Yale University School of Medicine. Cloth. Price. $3. Pp. 399. Stanford University, Calif.: Stanford University Press, 1946.*

This is the fourth edition of the "Health Instruction Yearbook." It contains abstracts of 384 articles from 83 different sources. A new chapter on international health has been added. This addition appears justified in view of the growing significance of world affairs in American thinking and by the fact that major health problems are seldom restricted for long by geographical boundaries alone.

One of the major problems of the present day is the growing complexity of science and the mounting mass of scientific literature, with which it is almost impossible for any one individual to keep pace. In such a field it is clear that no single textbook or no group of textbooks can be adequate. This fourth edition of this book fills an important place as an up-to-date summary of recent advances in health. It is suitable for either text or reference use for students, teachers, public health workers, nurses and others interested in the maintenance of public health.

**Harvey Cushing: A Biography.** *By John F. Fulton. Cloth. Price, $5. Pp. 754, with illustrations. Springfield, Illinois: Charles C. Thomas, 1946.*

This is the biography of a great medical pioneer. John Fulton, the author, is now Sterling Professor of Physiology at Yale University and Cushing's literary executor. While he lived, Harvey Cushing had stimulated a generation of medical students and it is evident that this record of his life will prove a source of inspiration to students for many generations to come.

There are many things in Cushing's life of great interest to physical therapists. For instance when he was in France in the first World War he had an attack of polyneuritis. "As soon as possible he insisted on daily exercise and massage. Sidney Q. Schwab, writing to Cushing many years later said: 'I was thinking . . . of the therapeutic side of your case and I believe the effort we made to get you up and about, to do everything, to make you ambulatory rather than to keep you in bed was good therapy in spite of the conventional ideas against it.'" "The use of high-frequency currents in surgery did not originate with Cushing, but their value in neurological surgery was first established by him. . . . 'I had persuaded Dr. Bovie to bring his electrosurgical unit over here to let me see what I could do with his cutting loop.' . . . After several months' further trial with the unit which Bovie had devised, the circuits were submitted to the Liebel-Flarsheim Company for commercial construction. Mr. Liebel, the head of the firm, took a personal interest in the development and as a pilot in his own right he flew his plane back and forth to Boston on many occasions while the new equipment was being perfected and presented Harvey Cushing with the first unit."

Doctor Fulton has had access to unusually rich source materials—the diaries, sketches, personal correspondence and papers which Cushing systematically preserved throughout his life. The biography includes in Cushing's own words, descriptions of skirmishes with his father over playing college baseball, his decision to leave medical school when a patient he anesthetized died; his operation for the removal of a large meningeal tumor on General Leonard Wood. The negotiations for bringing together a base hospital ended in a struggle which Cushing picturesquely termed "The Battle of Boston Common." It relates the experiences of Base Hospital No. 5, organized by Cushing in the first World War, the bombing and Cushing's threatened court martial in 1918. It gives an account of the many honors heaped on Cushing for his achievements in medicine and literature.

This is a distinguished biography of a man who wanted above all else to be "a good doctor," written with simplicity and remarkable detachment by one of his more renowned pupils.

**The Treatment of Bronchial Asthma.** *By Vincent J. Derbes, M.D., Instructor in Medicine, Tulane University of Louisiana School of Medicine; Director of Department of Allergy, Ochsner Clinic, and Hugo T. Engelhardt, M.D., F.A.C.P., Instructor in Clinical Medicine, Baylor University College of Medicine, Houston, Texas. Cloth. Price, $8. Pp. 366, 61 illustrations. Philadelphia, London, Montreal: J. B. Lippincott Company, 1946.*

Bronchial asthma is one of the most discouraging and disheartening disorders to treat, particularly since the asthma problem seems to cover a wide variety of diagnostic and therapeutic procedures with which the average practitioner is not familiar. In this book the subject matter has been attacked from the standpoint of the allergist, the general practitioner and the specialist in other fields. Nineteen authors have pooled their resources to produce an outstanding book. The first part deals with fundamentals while the second part treats the clinical aspects including both diagnosis and treatment. For all those who have to treat asthma patients this book seems an absolute must.

**What's My Score? Handbook for Patients with Disabilities Resulting from Spinal Cord Injuries.** *Paper. Pp. 36, with illustrations. Washington, D. C.: Veterans Administration, 1946.*

This profusely illustrated pamphlet is issued by the Medical Rehabilitation Division, Department of Medicine and Surgery, to pass on to patients with spinal cord injuries a few helpful hints which will enable them to live a life of independence.

**Motor Disorders in Nervous Diseases.** *By Ernst Herz, M.D., Instructor in Neurology, College of Physicians and Surgeons, Columbia University, and Tracy J. Putnam, M.D., Professor of Neurology and Neurological Surgery, College of Physicians and Surgeons, Columbia University. Cloth. Price, $3. Pp. 184, with 250 illustrations. New York: King's Crown Press, 1946.*

This little book is an outgrowth of a series of films made at Columbia University. The book is exactly what its title indicates, a compact description of motor disorders with a wealth of illustrations. For physical therapists who want to refresh their memory of this subject the little book will be invaluable. The book is so abundantly illustrated that it can be used as a text without the films.

**Experimental Hypertension: Special Publications of the New York Academy of Sciences, Volume III.** *By William Goldring, Richard J. Bing, Eduardo Cruz Coke, W. D. Collings, L. W. Donaldson, M. L. Goldberg, Harry Goldblatt, B. Gomberg, Arthur Grollman, C. A. Johnson, Oliver Kamm, Louis F. Leloir, H. Minatoya, W. G. Moss, Eric Ogden, Irvine H. Page, John W. Remington. L. A. Sapirstein and G. E. Wheelin. Cloth. Price, $3.75. Pp. 179, with 40 illustrations. New York: Academy of Sciences, 1946.*

This book is the result of a conference on experimental hypertension held by the section of biology of the New York Academy of Sciences on February 9 and 10, 1945. Its publication in book form is a very valuable addition to the scientific physiological literature. The role of the renin angiotonin mechanism in the elevation of blood pressure was discussed. Pressor and antipressor substances are considered. Even though the papers at the symposium were mostly concerned with animal experiments there is added to the book a statement on the question of similarity in pathogenesis of experimental renal hypertension and human hypertension. For those who want to familiarize themselves with the most recent developments in this field, the book offers a complete survey of this complex but important subject.

**Character-Analysis: Principles and Technic for Psychoanalysts in Practice and in Training.** *By Wilhelm Reich. Translated by Theodore P. Wolfe. Second edition. Cloth. Price, $4.50. Pp. 328, with illustrations. New York: Orgone Institute Press, 1945.*

This is the first English translation of this book although it is the second edition of the original which was published in 1933. It comes from the pen of a prolific and profound writer in psychoanalytic literature and is written for psychoanalysts.

The main thesis presented by the author is the fact that one must not only hear what is being said but also understand what one sees during therapy in terms of the character of the individual and how he clothes himself in a protective armor against internal and external stresses. To review this book properly would require much more space than is available or considerate for this journal. Suffice it to say that it is an excellent piece of work for psychiatrists. It presents a complete picture of studies of certain types of personalities and how to handle transference and resistance as presented by them. However, there is nothing in it that could interest anyone but those who are directly dealing with psychiatric cases in therapy.

**Body Mechanics in Nursing Arts.** *By Bernice Fash, B.P.E., B.S., Instructor of Physical Education, Cook County School of Nursing, Chicago. Foreword by Lucile Petry, Editor, McGraw-Hill Series in Nursing. Cloth. Price, $2.75. Pp. 130, with 95 illustrations. New York: McGraw-Hill Book Company, Inc., 1946.*

Miss Fash became interested in her present position in helping student nurses overcome their problems of fatigue. In 1944 Miss Fash assisted in the preparation of a booklet on body mechanics for cadet nurses. This booklet, called "Figuratively Speaking," was issued by the Division of Nurse Education of the Federal Security Agency, United States Public Health Service.

A preventive program is presented to help the nurse become more efficient in physical skills, avoid fatigue, remove muscular stress and strain and prevent the development of postural defects. Following each experiment in the first section, the principles utilized are listed with examples of how the student may apply the principle. The second section deals with specific problems of physical activities in nursing procedures and explains how these procedures may be improved through the application of the principles.

**Textbook of Neuropathology.** *By Arthur Weil, M.D., Associate Professor of Neuropathology, Northwestern University Medical School, Chicago. Second edition. Cloth. Price, $5.50. Pp. 356, with 287 illustrations. New York: Grune & Stratton, 1945.*

The second edition of this textbook in neuropathology continues the excellent production in the first edition. The author has kept the size of the book to no appreciable increase and has brought it up-to-date. It is clearly written and can be easily understood by the novice. The addition of some sound psychological and clinical references makes it more useful. The subjects discussed cover the general field of neuropathology. The usual diseases are considered in their groups such as inflammatory diseases, tumors, etc. The newer advances have been added. The illustrations are excellent and the bibliography is complete. It may be well recommended for neurologists and particularly for those who are seeking a good foundation in neuropathology.

**Peripheral Vascular Diseases.** *By Edgar V. Allen, M.D., Associate Professor of Medicine, Mayo Foundation, Graduate School, University of Minnesota; Nelson W. Barker, M.D., Associate Professor of Medicine, Mayo Foundation, Graduate School, University of Minnesota; Edgar A. Hines, Jr., Associate Professor of Medicine, Mayo Foundation, with Associates in the Mayo Clinic. Cloth. Price, $10. Pp. 871, with 386 illustrations. Philadelphia: W. B. Saunders Company, 1946.*

Peripheral vascular diseases are too extensive to permit adequate presentation by a single physician or surgeon. Therefore, this book is based largely on the experiences of the authors and their colleagues in the Mayo Clinic. This presentation indicates clearly that there remains a vast and fruitful field for research in this particular phase of medicine.

The authors discuss peripheral vascular diseases in the broader sense of the term, and while the term overlaps many other fields of medicine and surgery, this book discusses the field fully. The following subjects show how this book is valuable as a reference book for physical therapists.

There is a chapter on diseases which primarily are effects of environmental temperature on the vascular system which considers sensitivity to cold and heat, pernio syndrome, trench foot and immersion foot and frostbite. Under thromboangiitis obliterans physical therapy is fully considered. The chapter on medical treatment and special technics gives the authors' experiences on most physical agents used in the treatment of peripheral vascular diseases. They say, for instance: "We have read Fatheriee's report and it has been our impression that the water of Soap Lake has, per se, no peculiar value in the treatment of peripheral vascular diseases." This chapter also discusses general care, diet, mecholyl by iontophoresis, tobacco, refrigeration, ice packs, hot packs, prevention of edema, postural exercises such as Buerger's and the Buerger-Allen exercises, contrast baths, radient heat, giving several pictures of apparatus to apply the correct amount of heat, environmental temperature, short wave diathermy, the heating sleeve, and heating boot, passive vascular exercise, intermittent venous compression and the oscillating bed. Every agent is evaluated. For instance, the authors' state: "We have continued to use the Sanders bed intensively. The best results are secured when patients are treated for long periods, and it is our custom now to furnish one Sanders bed for every two patients, so that each of them may have from ten to twelve hours of treatment a day."

In addition to being recommended as a reference book for physical therapists, this book is highly recommended to physicians, internes and residents who must treat patients with peripheral vascular disease.

**Music in Hospitals.** *By Willem von de Wall, Head, Adult Education Section, Education Branch, Internal Affairs and Communications Division, Office of Military Government for Germany. Paper. Price, $1. Pp. 86. New York: Russell Sage Foundation, 1946.*

Music has been used to comfort sick persons since time immemorial. In the past twenty-five years, however, notable progress has been made in the systematic application of music as a means of occupational therapy and of recreation. The systematic application of music as a medically coordinated means of modern hospital treatment is still in its infancy. Serious efforts are being made today by some members of the medical profession to develop in collaboration with musicians a medically acceptable technic for using music in hospital treatment. This handbook discusses some aspects of continuing significance that need clarification and development. The principles and practices set forth here are not presented as final conclusions, but as thoughts and suggestions based on practical experience and offered for purposes of information.

**Developmental Anatomy: A Textbook and Laboratory Manual of Embryology.** *By Leslie Brainerd Arey, Ph.D., Sc.D., LL.D., Robert Laughlin Rea Professor of Anatomy, Northwestern University. Fifth Edition. Cloth. Price, $7. Pp. 616, with 590 illustrations, many in color. Philadelphia: W. B. Saunders Company, 1946.*

This edition of this popular textbook replans and improves the presentation of the topics comprising general development. Much of the material is rewritten, not only bringing the material up-to-date but incorporating important improvements in arrangements and adding measurably to the teaching qualities of the text as a whole. Outstanding among the new and revised material are the discussions of growth and histogenesis, maturation, cleavage and gastrulation, human embryos and their membranes and placentatis. Consideration of the fetal membranes of vertebrates in general has been segregated and unified. There are entirely new chapters on reproductive cycles and their hormonal control and on the fundamental concepts and problems of experimental embryology.

The world literature in embryology since 1940 is reviewed, particularly as it affects human development. Superscripts interspersed throughout the text agree with the numbered entries in a bibliography at the end of each chapter. These citations direct attention to newer or controversial interpretations. In some instances recent contributions with comprehensive literature reviews have been given preference in citation over more weighty but older researches.

As in previous editions this book comprises both a text and laboratory manual. It is highly recommended as a textbook and laboratory manual of embryology.

**Medical Education and the Changing Order.** *By Raymond B. Allen, M.D., Ph.D., Executive Dean, Colleges of Dentistry, Medicine and Pharmacy, University of Illinois, Chicago. Cloth. Price, $1.50. Pp. 142. New York: The Commonwealth Fund, 1946.*

This monograph presents the philosophy of the place of medical education in the culture of our times. This monograph is not a report of a survey, or in any sense a comprehensive analysis of medical education but it does define in broad terms a contemporary philosophy of medical science. The author believes that medical education like medical science is an experimental art. What is said will interest all physical therapists interested in medical education. It points out what appear to be some of the difficulties of present-day medical training in meeting the needs of a constantly changing society and suggests possible ways of overcoming these inadequacies.

Much that applies to the education of physicians applies to the education of physical therapists. For instance: "Progress in medical education and science depends on those students who retain the vital impulses of curiosity and imagination throughout their lives. There is good reason to suppose that some of the present methods of formal education blunt rather than sharpen these essential qualities." "General education and the premedical collegiate level should be planned to provide opportunities for adequate preparation in the biological and physical sciences, avoiding the dangers of too great concentration in either field in order to allow sufficient time for studies in social sciences and the humanities."

**The Challenge of Polio: The Crusade Against Infantile Paralysis.** *By Roland H. Berg. Introduction by Basil O'Connor, President, The National Foundation for Infantile Paralysis, Inc. Cloth. Price, $2.50. Pp. 208. New York: The Dial Press, 1946.*

This is the story of polio written for the lay public. The answers are here in the accomplishments and setbacks of the nation's leading scientists as they fight laboratory battles with the unseen polio virus, midget of the microbes, yet responsible for thousands of crippled bodies. In this story you follow the scientists on the most intensive germ-hunt ever undertaken by men of medicine.

In the chapter "Is Crippling Necessary?" the author writes the story of the treatment by Miss Kenny. This is of interest to every physical therapist who is often required to answer questions regarding this method. Among the statements the author states: "Dr. John F. Pohl, who has been closely associated with Miss Kenny since her arrival in this country and is staff orthopedist at the Kenny Institute, recently published an interesting survey. . . . According to Pohl's statements, 364 patients have been Kenny treated at Minneapolis since 1940. During this time twenty-three of the patients died. Of the 341 patients who survived, Doctor Pohl states that fifty-five or sixteen per cent have been left with extensive residual paralysis." Pohl's report does point out that the Kenny technic is good, but it is not the spectacular cure which the public has been led to believe.

This book can be highly recommended to those interested in poliomyelitis, because it gives a better understanding of the nature and the size of problems which confront our scientists in their monumental task.

**Diseases of the Nervous System.** *By F. M. R. Walshe, O.B.E., M.D., F.R.C.P., Physician in Charge, Neurological Department, University College Hospital, London; Physician to National Hospital for Nervous Diseases, London. Fourth Edition. Cloth. Price, $4.50. Pp. 360, with 51 illustrations. Baltimore: The Williams and Wilkins Company, 1945.*

In the fourth edition of his previously well accepted book the author has maintained his usual excellent standard. It is a small selected book for the novice in neurology and as such far surpasses any of the more recent "handbooks" which have come to the attention of the reviewer.

The first part of the book is one of its most valuable assets. In it is discussed localization of function with clear physiologic interpretations.

The remainder and greatest part is devoted to a descriptive account of the more common diseases of the nervous system. No attempt is made to go through the complete gamut of neurologic entities but the commonly encountered types of cases are considered. The more recent knowledge has been added and the book is up-to-date. In particular, therapy is not neglected.

It is clearly and concisely written. There is no excess verbiage and no cumbersome academic discussions. It cannot be considered a reference book in neurology but it well fulfills the purpose as postulated by the author and may be highly recommended to medical students and general practitioners. It also may be valuable to physical therapists who have some basic knowledge of neurology and wish to amplify their knowledge about the cases they treat.

**Convalescent Care for Children.** *Proceedings of the Conference held at Hershey, Pennsylvania, April 19-20, 1945. Paper. No charge. Pp. 143. Chicago, Illinois: National Society for Crippled Children and Adults, Inc., 1946.*

This pamphlet presents papers on adequate convalescent facilities not only for ill and injured veterans but for the children suffering from those ailments characterized by long drawn-out convalescent periods, or long periods of training and reconditioning, where institutional surroundings are necessary.

**Cyclopedic Medical Dictionary, Including a Digest of Medical Subjects: Medicine, Surgery, Nursing, Dietetics, Physical Therapy.** *By Clarence Wilbur Taber and Associates. Fourth Edition. Cloth. Price, $3.50. Pp. 1500, with 273 illustrations. Philadelphia: F. A. Davis Company, 1946.*

This new edition contains nearly 1500 pages. It retains the double column page which makes it possible to present at least one-third more material than is found in other like dictionaries. It includes between 50,000 and 60,000 words—only a few thousand less than the vocabulary of the large unabridged medical dictionaries. The cyclopedic character of the definitions has been retained.

Some twenty new features are represented, including 273 illustrations. It is authoritative and up-to-date in every respect. Page numbers are not consecutive throughout the book as each letter of the alphabet has its own page numbers. This is done to make possible subsequent additions without changing all the page numbers.

It can be recommended as a cyclopedic medical dictionary, which means that it is a source book of medical knowledge that will save much time in consulting a great many other works.

**Stedman's Practical Medical Dictionary.** *Edited by Norman Taylor, M.D. 16th Edition. Cloth. Price, $7.50, with thumb index. Pp. 1267. Baltimore: The Williams and Wilkins Company, 1946.*

The sixteenth edition of Stedman is thoroughly revised yet it retains its valuable features. Simplicity and correct spelling, with the elimination of useless diphthongs and word endings, and the substitution of English for foreign words when possible is carefully set forth. It includes all the medical, surgical, pharmacal, biological, chemical, dental and thousands of other related scientific terms that you encounter daily. It is well illustrated with just the pictures of practical value where definition alone is difficult.

Some special features are a section on medical etymology; printing of the Greek roots of medical words in Roman letters; brief description of the technic of clinical laboratory tests; inclusion of official pharmaceutical preparations; and an appendix covering weights and measures, tables of chemical elements, pathogenic microparasites, temperature and barometer scales. This edition can be highly recommended as a practical medical dictionary.

**The Outlook for Women in Occupations in the Medical and other Health Services: Trends and Their Effect upon the Demand for Women Workers.** *Bulletin 203-12. Paper. Price, 10 cents. Pp. 55. Washington 25, D. C.: U. S. Department of Labor, Women's Bureau.*

This bulletin is a final bulletin in a series which, for selected occupations in this field, presents the prewar situation of women, reviews the wartime changes, and discusses the future outlook. The recent changes which have exerted a special and differential influence on certain of the occupations also are considered. These specific influences on physical therapy are described more fully in a separate pamphlet—bulletin 203-1.

**The Principles of Neurological Surgery.** *By Loyal Davis, M.S., M.D., F.A.C.S., Ph.D., D.Sc. (Hon.), Professor of Surgery and Chairman of the Division of Surgery, Northwestern University Medical School, Chicago, Illinois. Third Edition. Cloth. Price, $7.50. Pp. 540, with 348 illustrations. Philadelphia: Lea & Febiger, 1946.*

This new edition is of timely aid in the diagnosis and treatment of all neurological conditions. It covers fully craniocerebral injuries, intracranial tumors and abscesses, the surgical lesions of the cranial nerves, injuries of the spinal cord and peripheral nerves, tumors of the skull and spinal cord, and the surgery of the autonomic nervous system. Such topics as pain and the surgical treatment of epileptiform seizures, paralysis agitans and the psychoses also are covered.

There are still many patients who receive erroneous advice as to just what can be accomplished in the surgical treatment of their conditions. This book gives physicians and students easily assimilable facts that will clarify their concept of neurological surgery and enable them to give their patients more accurate and sound advice.

It can be recommended to physical therapists as a book of reference for this subject, especially spinal cord injuries and injuries of the peripheral nerves.

**Mental Disorders in Later Life.** *Edited by Oscar J. Kaplan. Cloth. Price, $5. Pp. 436, with 14 illustrations. Stanford University: Stanford University Press; London: Oxford University Press, 1945.*

There is much merit in a book which brings together information regarding the psychiatric and sociologic aspects of the aging process. It is indeed revealing that such information is accumulating so rapidly as to warrant such a book. It is edited by a psychologist who also contributes excellent chapters on the psychological aspects of mental disorders in later life and the aged subnormal. There are contributions by other psychologists and a physiologist which help to elucidate the problems of aging. There is an excellent chapter which is a statistical review of mental disorders in later life and one on the sociological aspects of mental disorders in later life by eminent workers in their fields. The remainder of the seventeen contributions deal with the more strictly psychiatric studies. They present a source of material which is highly informative and readily available. The chapters on psychotherapy and mental hygiene provide the reader with a wholesome approach to the treatment of the aged, for mental or physical disability.

Although the form of the book produces considerable overlapping of material between contributors, this defect is not a serious one. There is an ample bibliography after each chapter. It is a book which may be recommended highly to all people working in the related fields. The individual authors are to be complimented on the clarity of their contributions.

**Nursing and Nursing Education.** *By Agnes Gelinas, R.N., A.M., Professor of Nursing and Chairman of the Skidmore College Department of Nursing, New York Post-Graduate Medical School and Hospital. Cloth. Price, $1. Pp. 72. New York: The Commonwealth Fund, 1946.*

This brief but meaty book should be read by physical therapists after reading the series of "A History of the American Physiotherapy Association" which appeared in The Physiotherapy Review this year. It shows that nursing as we know it today is a relatively young profession. The public wants more facilities, wider distribution of service and lower costs. It wants more nursing, but doesn't concern itself too much with what makes a good nurse. The author emphasizes that the importance of nursing education in relation to nursing service must be more widely publicized. At the middle of the last century nursing in institutions seems to have been on the same level as nursing in the home. The nurse cared for the patient as best she could, combining housework and custodial duties. The opening of schools of nursing in New York, New Haven and Boston in 1873 marked the beginning of trained nursing in the United States. From 1873 to 1893 reforms in nursing were confined largely to matters of hospital housekeeping.

Physical therapists can read the following statements and compare nursing with physical therapy: "Although the beginnings of university connections with schools of nursing were sporadic, there is now an accelerated trend toward collegiate schools of nursing." "It may be said that a little more than a decade after the first three training schools were opened the three major fields of nursing had taken root: private practice, institutional and public health. Later a fourth classification appeared —nursing education." "The concentration of teaching and training facilities in a few strong schools rather than in many schools of uneven quality is an important factor in planning for nursing education and service." Last but not least in comparing physical therapy with nursing is the author's statement: "Because of the present deficiencies in trained personnel and in facilities for proper medical and nursing care, the Committee is fully aware that a comprehensive job cannot be done at once."

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# Meet Our Contributors

**Dillon, Edna L.,** 1st Lt., MDPT, Percy Jones General Hospital Annex—Staff, Fort Custer, Mich. Lieutenant Dillon received her B.P.E. Degree from American College of Physical Education, Chicago, Illinois, in 1942, and her certificate of physical therapy from Brooke General Hospital, Fort Sam Houston, Texas, in 1944. Since that time she has been employed as physical therapist at the Percy Jones General Hospital. Member: American Physiotherapy Association.

**Hellebrandt, Frances A.,** Richmond, Va.; Professor of Physical Medicine and Director, Baruch Center of Physical Medicine, Medical College of Virginia, Richmond. Doctor Hellebrandt received her B.S. Degree from the University of Wisconsin in 1928, and continued her studies there to receive her M.D. Degree in 1929. She was employed by the University of Wisconsin and held the following positions: Assistant in Anatomy, 1924-27; Instructor in Physiology, 1928-29; Assistant Professor of Physiology, 1930-36; Associate Professor of Physiology 1936-42; Associate Professor of Physical Medicine and Research Associate in Physiology, 1942-44. In 1944 she accepted her present position with the Baruch Center of Physical Medicine. Member: American Physiotherapy Association.

**Hoag, Dorothy G.,** 1st Lt., MDPT, Signal Corps Photographic Center, Long Island City, New York; technical advisor, training film project No. 10990—therapeutic exercise. Lieutenant Hoag received her B.E. Degree from State Teachers College, Moorhead, Minn., in 1937; her M.A. Degree from State College of Education, Greeley, Colo., in 1941, and her certificate of physical therapy from Fitzsimons General Hospital, Denver, Colo., in 1944. Since that time she has been employed at Fitzsimons General Hospital, Denver, and in her present position with the Signal Corps Photographic Center. Member: American Physiotherapy Association, American Registry of Physical Therapy Technicians.

**Houtz, Sara Jane,** Richmond, Va.; research assistant, Division of Clinical Research, Medical College of Virginia, Richmond. Miss Houtz graduated from the University of Colorado, Boulder, Colo., in 1939, with a B.S. Degree, and received her certificate of physical therapy from Walter Reed General Hospital, Washington, D.C., in 1942. She served with the U. S. Army, 20th General Hospital, in India, January 1943 to May 1945, and at Camp Carson, Colo., from May 1945 to November 1945. As an emergency technician she worked for the National Foundation for Infantile Paralysis from

November 1945 to February 1946, at which time she accepted a position as Instructor in Physical Therapy, Medical College of Virginia. Miss Houtz served in this capacity until August 1946, when she took over her present duties as research assistant. Member: American Physiotherapy Association; American Registry of Physical Therapy Technicians; Virginia Academy of Science.

**Parrish, Annie M.,** Richmond, Va.; Assistant to the Medical Director, Baruch Center of Physical Medicine, and Instructor in Physical Therapy, Medical College of Virginia. Miss Parrish received her B.S. Degree from the Woman's College of the University of North Carolina in 1941, and her certificate of physical therapy from University of Wisconsin in 1945. Since that time, she has been employed in her present position. Member: American Physiotherapy Association; American Registry of Physical Therapy Technicians; American Association of Health, Physical Education and Recreation.

**Piersol, George Morris,** University Hospital, Philadelphia 4, Pa.; Professor of Medicine, Graduate School of Medicine, University of Pennsylvania, and Director of the Center for Instruction and Research in Physical Medicine, University of Pennsylvania. Doctor Piersol received his B.S. and M.D. Degrees from the University of Pennsylvania, 1905. Member: American Medical Association; Advisory Council, American Physiotherapy Association.

**Windham, Georgiana,** 2633 16th Street N. W., Washington, D. C.; physical therapist at Kabat-Kaiser Institute, Washington, D. C. Miss Windham graduated with a B.S. Degree in Health and Physical Education from Texas State College for Women, Denton, in 1940, and received her certificate of physical therapy from Brooke General Hospital, Fort Sam Houston, Tex., in 1944. She served as a physical therapist with the U. S. Army at Brooke General Hospital from 1944 to 1946, when she accepted her present position. Member: American Physiotherapy Association.

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